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SOME PROBLEMS IN FUNDAMENTAL ASTRONOMY[1]

By Dr. HERBERT R. MORGAN

U. S. NAVAL OBSERVATORY, WASHINGTON, D. C.

IN presenting the subject of fundamental astronomy before this section it has seemed proper to consider in an elementary manner, and from an observational standpoint, some of the more important phases of the work, such as the general problem of determining positions in space, the progress of work on star places and some of the problems in the solar system.

There are possibly fifty observatories in this country where some form of astronomical observations are carried on at the present. By far the larger part of this work is in the line of astrophysics or the new astronomy. The advances in this line are remarkable. We are living in an era of creation of great reflecting telescopes. In this country alone there are eight or ten great mirrors with reflecting surfaces of from 20 to 200 square feet, now in use or under construction. Explorations into the space of the galaxies appeal to the imagination, and large sums of money are subscribed for such work. There is great interest and activity in, and remarkable increase in our knowledge through, the use of the spectroscope and photography. Our publications are full of interesting information as to what is going on in the stars and galaxies, and a different size of the universe is presented for our consideration every few years.

No such expansion is noticeable in positional astronomy. Mass production of routine observations and endless computations are prosaic and uninteresting to the uninitiated, and only exceptional men revel in celestial mechanics.

In this country fundamental observations for posi-

[1] Address of the retiring vice-president and chairman of the Section on Astronomy, American Association for the Advancement of Science, Atlantic City, N. J., December 31, 1936.

tion are continuous at one observatory only; at another photographic catalogues are being determined; at a third a general catalogue is being constructed; and a limited amount of positional work is done elsewhere. As the geometry of the universe depends basically upon positional astronomy it may be worth while for a few minutes to consider some of the processes and present needs of fundamental observations and the value of the base lines they furnish for measuring the heavens.

The way in which the size of the universe is deduced may not seem so complex, but the measurements are quite restricted in precision and complicated by many physical limitations.

Primitively we may say that the universe is measured with a foot rule. Geodesists with their standard tapes measure arcs of the earth's surface which astronomical observations show subtend certain angles at the earth's center, and from this the size of the earth is deduced. Then with two points on the earth as a base line astronomers triangulate to the planets or sun and obtain the sun's distance—the fundamental unit for all measurements of celestial distances. And finally using the sun's distance as a base line the distances of the nearer stars are found, also by triangulation. To obtain the distance of the stars the tape is multiplied a thousand million million times.

Accurate measures of distances are limited to the nearer stars. No direct measures of the distances of the great mass of stars are now possible. Precision measures furnish also positions and proper motions, and the spectroscope furnishes velocities in line of sight. There are now available positions for half a million stars; proper motions for 100,000; radial velocities for 7,000; and parallaxes for 4,000 stars.

With this precision data as a basis statistical studies furnish material for indirect or inductive methods of determining distances and motions of the stars in general. The dimensions of the universe of to-day rest largely upon these statistical methods, which give approximate rather than precise results, but which are the only methods available and are indispensable. The accuracy in such results depends upon the accuracy of the fundamental data as well as upon the statistical analysis and derived formulae.

The problem, however, is not simple; the determination of the positions and motions of the heavenly bodies is very complicated, and for a clearer understanding it is convenient to have in mind a few elementary ideas as to where the observer finds himself in space, and to realize how he must spend the larger part of his time in determining his own position and motion and the positions and motions of the coordinate planes to which the celestial objects are referred.

If now from some point, fixed in space with reference to any chosen group of stars, we should space out the stars at two different epochs we should have their directions and cross motions on the celestial sphere. The apparent direction of a star would differ from the true or real direction at any instant by the amount of cross motion in the interval of time it takes light to come from the star. Our catalogues define the directions in which we see the stars, not the true directions in which they are at that instant. Groombridge 1830 is really three minutes of arc away from the direction in which we see it. A double star may make several revolutions in the time its light is coming to us. We define the directions of the planets as they are to-day; of the stars and clusters as they were years and centuries ago; and of the spiral nebulae as they were ages in the past, when the solar system was far off in space from where it is now.

But we are not at a fixed position but are moving among the stars in our local system with the motion of translation of the solar system of some 390,000,000 miles a year. At the apex of this motion the stars are apparently separating, while at 90° from it they are drifting past us by amounts depending upon their distances. As the distances of the stars have been unknown in general, the apparent motion of the star due to the sun's motion and the real motion of the star itself have not been separable. All proper motion catalogues of to-day give the sum of these two motions. The catalogues of the future must separate them. So far the value of the solar motion has varied with each group of stars chosen for a reference system.

Not only does the sun's motion affect the proper motions, but the secular aberration due to this motion changes the direction in which we see the stars by amounts varying from zero at the apex to 13″ at 90° from it, and this affects all stars alike independent of their distances. By convention, and for convenience, this anomaly also adheres to our catalogues, which give the directions in which we see the stars rather than the directions they would have if we were not moving.

For a more complete picture of the sun's motions there should be mentioned also its motion, with the local system of stars, of 200 miles a second towards an apex among the globular clusters, or around the center of the galaxy, with corresponding aberrations of 200″ or more.

We are not only moving with the sun, however, but with the earth in its annual motion of 585,000,000 miles around the sun, giving rise to annual parallax and aberration. And here again as the distances of the stars have been unknown, catalogue positions up to the present have not been corrected for annual parallaxes, though these are small.

The most noticeable change in a star's position due to the earth's motion around the sun is the annual

aberration which may change its place by as much as 41″. This has been understood since accurate observations began, and they have been corrected for it. To know its true value at any instant it is necessary to know the direction and amount of the earth's motion at that time. This requires a knowledge of the size and shape of the orbit, such as the solar parallax, the eccentricity and perihelion, and the position of its plane, the ecliptic and the equinox, and also the constant of aberration. It is also necessary to know the directions, distances and masses of disturbing planets, in order to take into account their perturbations. The velocity of the earth varies with perturbations, with its motion around the center of gravity of the earth-moon system, and in its eccentric orbit.

It is realized, therefore, that before the true direction of a star at any time may be determined it is necessary to know the motions of the earth and other objects in the solar system.

The motion of the earth with the sun in space, and its variable motion around the sun, both enter into the determination of velocities in the line of sight, hence accurate tables of motion of the earth are necessary for all radial velocity results.

The most pronounced motion of which we are aware is the daily rotation of the earth, and this has determined another fundamental plane of reference, namely, the equator. But observations show that this plane is changing position among the stars with progressive and oscillating motions known as precession and nutation, which depend upon the shape, size and mass of the earth, moon and sun, and upon the elements of their orbits. For reduction of our observations it is necessary to determine the motions of these reference planes among the stars together with such constants as precession, nutation, obliquity and position of the equinox.

Besides the various motions of the observer with the earth as a whole of which we have been speaking, observations show small variations in periods of 12 and 14 months due to the variation of latitude or change of axis of rotation within the earth. Star places of the last century were uncorrected for this variation. It can be accurately determined only by observation, and is a continuing problem in position work.

Until recent years the rotation of the earth was believed to be uniform, and the earth has been used as a great clock to time the motions of the planets and stars. The evidence now is that this rotation varies and that astronomical time may vary as much as 70^s a century on uniform time. Nature furnishes other timekeepers, however. The most uniform time is determined for subdivisions of a day, by the oscillations of a crystal or a pendulum; for intervals of a year, by the rotation of the earth; and for parts of a century, by the revolutions of the moon and planets.

And finally our instruments are at the bottom of an ocean of air having refraction effects on rays of light traversing it, constantly varying with temperature, pressure, humidity and other changing conditions, the laws of which are not fully understood.

There is then no invariable point, line or plane in space to which we may tie the coordinates of the stars. We have therefore to set up a coordinate system with respect to the moving bodies in the solar system and determine its motion with reference to the stars. Professor E. W. Brown speaks of this as a moving frame of reference. Professor Lewis Boss considered that the problem of finding an invariable line of reference or direction in space is philosophically one of the most interesting problems which has been attempted in the whole range of science. Any system of reference planes and reduction constants becomes determinate only as the general motions in the solar system and the complex motions of the earth in particular become determinate.

The necessary and longer task of determining absolute or independent positions of the stars includes, therefore, that of determining the positions and motions of the sun and planets, the positions of the planes of reference and the fundamental constants of astronomy. As planetary motions may be determined only by reference to positions of the stars, continuous observations are required both of the planets and of the stars. The observations must be so planned and reduced as to define the coordinate planes in continuous motion among the stars and to furnish sufficient material for determining the planetary motions.

The process is one of successive approximation, first for the planetary motions, then for the star places. This is illustrated in history. The observations of Tycho Brahe in the sixteenth century permitted a solution of planetary motions by Kepler and his followers in the seventeenth century, which in turn made possible the accurate star observation results of Bradley and Bessel and their followers. From these came the tables and constants of Struve, Leverrier, Hansen and others, in the middle of the last century, forming the basis of observational work for the later part of the century, and resulting in the great fundamental catalogues of stars by Newcomb, Auwers and Boss. With these new positions of the standard stars the planetary observations of the last century were reconstructed into a great system of planetary and lunar tables and coordinated constants, by Newcomb, Hill and Brown. These new tables and constants, all marvels of analysis, have in turn made possible still more accurate star places, as exemplified by two recent

fundamental catalogues, the revisions of Auwers and Boss. These are both of great accuracy, and upon them another solution of the solar system will doubtless depend.

The observations are tedious and the reductions exacting, but the published results are milestones of progress in the unfolding of our own system, and they form a record of the sun's long journey among the stars.

Copernicus, in replacing the earth by the sun as center of the solar system, abolished the epicycle theories of Ptolemy and the ancients and demanded new theories and new orbits for the planets. Kepler and his followers lived with great anticipation as the new laws became understood. The aim of the observers 200 years ago was a new solution of planetary motions. The positions of the stars were of secondary consideration, and were used primarily for reference points. The sidereal motions as a whole received little attention. To-day the planetary motions are still of prime importance in themselves, but take on added importance in furnishing the coordinate planes and constants necessary to define accurate positions and motions in the great stellar universe revealed to modern astronomers.

Planetary and lunar theories are marvels of mathematical expression of gravitational laws. It is astonishing how complete a solution of the complicated motions in the solar system the mathematical astronomers have developed in the last 300 years, especially in view of the fact that they had remained an unsolved riddle for thousands of years. Accurate observations are less than 200 years old, yet positions of the planets are predicted within a few seconds of arc. All the larger perturbations in our system are known. New comets and asteroids, or even new planets may be expected, but their masses are feeble, giving less concern, for instance, than the uncertainty in the mass of Venus. There are still many interesting dynamical problems to be solved, and changes in theories are expected, but we look for no large deviation from theory, and certainly no dynamical upheaval such as seen in the novae. On the other hand, the streaming of the stars and the staggering dimensions and velocities of the galaxies, indicated by statistical studies, are absorbing attention, and call for expansion and increased accuracy in precision methods. The systematic errors in observed star places and motions must be distinguished from the real motions of the stars. Heretofore systematic errors in standard proper motions have amounted to $1''.0$ a century in several parts of the sky, and individual motions have been uncertain by similar amounts. A considerable part of this is due to errors in early catalogues, which can not be changed, but the influence of which may be reduced as new places are added in the solutions. A few thousand motions are now known within $0''.5$, and from existing data, 100,000 may be determined within $1''.0$ a century. These are quantities of the same order as some of those found for galactic rotation and for group motions. There is a need, therefore, for greater accuracy in our observations both for position and for proper motion.

The older national observatories were founded by various governments mainly to promote the interests of navigation. And the needs of navigation both for the Navy and for commerce in general are still important considerations at such observatories. Observations of the sun, moon and planets and the brighter stars are required for this purpose, and as such observations form the basis of fundamental astronomy, the government observatories have become largely the fundamental observatories. And this appears necessary. The continuous observation of these objects with the necessary exacting reductions are so time-consuming and laborious that only government, or heavily endowed institutions, can assure the required continuity and permanency.

The increase of power and speed in navigation and commerce has increased the importance of the time element, and to-day an important function of such an observatory is the determination and dissemination of accurate time. This requires the most perfect clocks and clock vaults, precision instruments and accurate star places. Free pendulum clocks carry time so uniformly that they detect minute nutations in the earth's motion amounting to ${}^{s}02$ every two weeks. Such clocks at the Naval Observatory are now rated by photographic observations of transits of zenith stars each 24 hours. The zenith telescope used for this purpose gives results somewhat more accurate than those from transit instruments. The time signals are sent out under control of crystal oscillator clocks. While in the past poor clock systems produced considerable errors in observations, to-day the best clocks kept under constant temperature and pressure are appreciably more accurate than the observations.

The first substantial fundamental work was done by Bradley about 1750, using a mural quadrant and a transit instrument. The work has been continued at Greenwich since that time, a mural circle replacing the quadrant in 1812, and the transit and circle combined into a transit circle in 1850. Observations were begun at Paris about 1800; a little later at Königsberg by Bessel, using a transit circle; at Pulkowa by Struve, using the transit and a vertical circle as separate instruments; and at Washington by Newcomb, using a transit circle. And there were shorter series. These men, and their successors, endeavored to establish

positions of the brighter stars with great accuracy and to accumulate material for construction of the planetary and lunar tables.

At the beginning of the last century, however, the desire for positions of more stars and of the faint stars diverted observational facilities, to a considerable extent, into mass production of less accurate positions, as illustrated by the great zone works of Lalande, Bessel, Argelander and others. And soon after the middle of the century cooperative work was started to determine fairly accurate positions of all stars to the ninth magnitude and fainter. This was begun some 70 years ago and the last southern zones are just now being observed. Twenty observatories or more have cooperated in the program. This work is now being repeated, using photographic plates, the transit circles furnishing positions of the 25,000 reference stars required for plate reduction. One half the program has been carried out this way in ten years. Additional instruments have been devoted to the plan of the astrographic catalogue for positions of all stars to the eleventh magnitude, started some years later and still far from completion. It has been impossible to carry out much of the meridian work planned for this undertaking. Thus the meridian instruments have been absorbed in mass production of only fairly accurate positions of something like a third of a million stars, and to some extent this has been with a sacrifice of fundamental observations.

The possibilities of the photographic plate furnishing positions of the fainter stars, suggested by the astrographic work, has, however, proven to be a turning point in positional astronomy. Very valuable work by Professor Schlesinger has shown that it is now possible to cover an area of 100 square degrees or more on one large plate. This reduces the number of reference stars required for photographing the sky to less than 50,000, and it reduces the task of the transit circle to one tenth that contemplated for it 50 years ago. Meridian observers welcome heartily the advent of photographic positions with the prospect that the great mass of faint star work may be cared for in this way and with the hope that more time may now be spent on fundamental work.

The recommendations of the International Astronomical Union at all its sessions have been more and more to encourage meridian work of greater precision on a well-spaced system of the brighter stars, and to carry to completion the great photographic surveys for positions of fainter stars. Dr. Kopff recently emphasized the need of series of meridian observations of absolute character and of the highest accuracy possible. He also expressed the view, emphatically, that long series of fundamental observations on the same instruments are a work of the highest value that astronomers can offer their science.

The change from the old to the new general plan for meridian work has been modifying observing programs of leading instruments for some years, and the new field is well established.

The new plan calls for a fundamental system of 2,000 or 3,000 stars to be kept under constant observation together with the sun, moon and planets.

Based upon this system, positions of some 40,000 or 50,000 standard stars, well spaced in the sky and including most of the stars brighter than the eighth magnitude, will be determined by meridian observations.

Based upon these standard stars, large photographic plates will give positions of all stars to ninth or tenth magnitude, and these in turn will furnish positions for all other photographic work.

In this way star places will become far more uniform and accurate by being based upon the same system and upon a standard system. This will do away with some of the accidental and systematic errors now attaching to zone catalogues based upon reference stars observed on individual instruments. By proper cooperation transit circles will be able to keep the standard stars under observation.

The great value of the photographic plate is in its economical and accurate differential spacing of large numbers of unknown stars among those whose positions are already known. At present photographic methods contribute little to absolute positions. The plate has neither divided circle nor uniform clock for independent spacing from pole to pole or from equinox to equinox. Meridian observers are aware of the fact that the plates must reproduce only too faithfully the systematic errors in their standard systems. Recently there is promise of using photographic plates, not for absolute spacing, but in determining the motions of minor planets relative to stars along their path. A difficulty here is to properly refer these stars to standard systems and coordinates. This is a difficulty in all differential work, where the zero points of the clock and circle or of the plate are determined from observations of reference stars only.

The fundamental catalogues which have been the standards since 1900 are now to be superseded by the Third Fundamental Catalogue of the Berliner Jahrbuch containing 1,500 stars and the new Albany General Catalogue of the Carnegie Institution with 32,000 stars. These two catalogues agree closely, and together will serve as bases of reference for positional astronomy for years to come. Inherently such catalogues are old before they appear, and these are already a third of a century old. They are most accurate at their

mean epoch, about 1900. The FK3 system is being used as a basis of photographic reobservation of all stars to the ninth magnitude, and it will be used in all national almanacs after 1939.

The fundamental catalogues have had from 1,000 to 1,500 of the historical bright stars, whose motions are now well known. In order to meet the needs of photographic work for more stars, and fainter stars, the Paris Conference, 25 years ago, increased the standard list to 3,000 by adding well-spaced stars from fifth to seventh magnitude. This was a matter of mature consideration by eminent astronomers in the conference. These stars have been well observed since that time and should be kept in the standard list. There is now another proposal to add 3,000 stars from the sixth to the ninth magnitude. Comparisons of observational catalogues with standard catalogues containing but 1,500 stars—one to each 27 square degrees—give very unsatisfactory systematic corrections. Moreover, it is very hard to get a sufficiently rigid reduction of an observational program with so few standard stars among the program stars. This has been shown by the discontinuities from zone to zone in the A. G. Catalogues and elsewhere. More fundamental stars are needed. The conclusions of the Paris Conference were that observations of the historical stars must be carried on with those of any new list. And this is still the opinion, and it is important. Dynamically the solar system is referred to them, and must continue to be. The motions of the bright stars are the best known, and they alone can be observed in the daytime—a necessity in this work.

A considerable portion of the information concerning the general structure of the universe comes from statistical studies of the fainter stars. The relation of the brighter stars to the fainter stars or of the local system to the more distant stars, clusters and nebulae is not at all well understood. The general motions in the solar system, such for example as the motion of the equinox, have been with reference to the nearer stars. If these are rotating or streaming with reference to distant objects the constants of our system may not be applicable to cosmic problems at large. And again a motion of the equinox referred to stars with large proper motions and in rotation will not represent the true dynamical precession of the earth. In the past all determinations of the precession constant have been made assuming a random motion amongst the stars used. Recent researches indicate the motion in the local system are not random, and that the local system has a high velocity as compared with more distant objects. The sun or the nearer stars may in time be found to have accelerations. Doubtless the spiral nebulae would afford a better reference system, but this would be possible only through comparison stars. Such observations, however, are now being made. The solar motion relative to the spirals is probably unappreciable with present measurements, and a true precession would result from such a solution. We can not, therefore, establish the absolute motion of the sun in space, but only its movement with respect to selected groups of stars. The growth of stellar dynamics has thus greatly enlarged the demand on fundamental observations, which now become concerned also with precision measures relating to objects in all parts of space.

With more recent instrumental methods for eliminating personal equation or care in determining it, observations are giving positions of the fainter stars quite correctly spaced as regards the bright stars. This was not realized in the past nor have corrections for it been satisfactory, the result being that the proper motions of the bright and faint stars differ, as though the bright stars were rotating or streaming on the faint background. It seems desirable for this reason also to have faint stars in the standard system in order to properly redetermine the systematic corrections to old catalogues and thus determine better motions for faint stars in large numbers. Such standard stars should be selected by magnitude, type and small proper motion so as to represent a distant and stable system.

The practical astronomer must spend considerable time in care, improvement and investigation of his instruments, notwithstanding that they are among the most highly developed instruments in the world.

The transit instrument and a vertical circle, used separately or combined into a transit circle, are the standard instruments for fundamental observations, though other types of instruments are being tried. The errors of all divisions on the graduated circles are carefully measured, and the irregularities in the pivots and micrometer screws are investigated. The spider webs used to follow a star across the meridian in the instruments at the Naval Observatory are driven by tiny synchronous motors built into the micrometers. This, together with the use of reversing prisms and screens, eliminates a very large part of the personal equation of the observers, and that remaining is determined from moving artificial images.

Twelve-hour circumpolar observations define the pole point of the instrumental meridian independent of star place, and stable meridian marks are used for determining very accurately the variation of azimuth.

In all absolute declination work the pole point of the graduated circle is determined from circumpolar observations. While with adopted flexures and refraction two standard instruments agree closely at the pole, they sometimes differ as much as 2″ in going 90° from the pole. This is attributed largely to flexure, the determination of which has always been unsatisfac-

tory. Some instruments are provided for interchange of object glass and eye end, but observations show that in most cases such interchange fails to eliminate the flexure. Reflection observations have never been conclusive as to flexure. New instruments show no improvement over old ones as to this error.

The best determinations of refraction are possible for observatories at high latitude such as Pulkowa, where stars south of the zenith may be observed also below pole. The Pulkowa refraction tables are now generally used and require little correction. The small deviations from them given by solutions of circumpolar observations represent mostly local conditions such as refraction around or in the building, location of thermometers, and daily and annual variations in such conditions. Such a solution represents the best value for reduction of work on the instrument used and possibly need not apply to other instruments with different local conditions. Modern buildings are constructed to allow free circulation of air and a wide exposure of the instruments to the open sky. Comparisons of observations in northern and southern hemispheres furnish additional information as to refraction, especially that towards the equator. In some locations the refraction seems to be different north and south of the zenith. Refraction solutions are frequently unsatisfactory, and both flexure and refraction require a careful investigation for each instrument.

For many instruments the pole point is the only zero point of the circle determined independently. Where the sun and planets are observed, however, a much stronger method of reducing declinations is possible, in that an additional point 90° from the pole and on the opposite side of the zenith is available. This principle was used by Newcomb in establishing his equatorial declinations, and these have held good for 70 years. It has been used in the new catalogue by Dr. Kopff, who expresses the opinion that Newcomb's method of using the sun and planets seems to be the best way of finding the errors of an instrumental system in declination at present. The determinations of the position of the equator and equinox are now made to depend upon day observations of the sun and inner planets, and also upon night observations of the moon and outer planets which are observed under the same conditions as the surrounding stars. The asteroids may also be used for this purpose. The differences between the day and night observations are determined from observations of bright stars, both day and night. Declination observations with different instruments reduced with solutions for both the pole and the equator agree within 0″.25 throughout the meridian.

For elimination of periodic errors and day terms observations extend over 12 to 24 hours each day, and include observations of the sun, Mercury and Venus, and bright stars during the day; observations of clock and azimuth stars, evening and morning 12 hours apart; and observations of the moon, planets and standard stars throughout the night.

It requires five to ten years to observe a catalogue of stars, and several years more to complete the reductions. The planetary observations continue with each catalogue. The final reductions of such work furnish corrections to the tabular positions of the planets and stars adopted for comparison, and corrections to reduction constants. From the circumpolar observations values of the constants of aberration and nutation may be determined. Newcomb's values of these constants are closely upheld by modern observations. Investigations of results from recent sun and planet observations uphold also Newcomb's position of the equator among the stars and his motion of the equinox. The right ascensions of his standard stars, however, must be decreased by ^{s}.04 or ^{s}.05 to satisfy observations with traveling threads.

The comparisons of such independent catalogues of stars taken at widely different epochs furnish the proper motions of the stars, and the combination of such catalogues forms a fundamental catalogue. In the recent fundamental catalogue FK3 the system has been based on the more accurate independent observations since 1845, and Newcomb's value of the precession is used. There are now possibly 3,000 stars whose positions are known within 0″.1, and, with application of systematic corrections, 300,000 within 0″.4 or 0″.5.

There is, however, a need for observations with smaller systematic errors. For this it is necessary to have more information as to day terms and refraction effects; better determinations of and greater elimination of personal and instrumental errors; improvements in instrumental equipment; and rigid observing programs. Work in astrophysical lines and with large reflectors, with its speedy output and interesting results, is very tempting. The tendency in this direction at fundamental observatories should, however, not be allowed to interfere with their already limited programs of fundamental work. The problems of astronomy are now so diverse and complex that the greatest success may be attained by concentrating the energies of each institution upon its major program and its supporting activities.

One half the observations used by Newcomb in his tables of the inner planets were made at two observatories only—Greenwich and Paris—and these show marked systematic differences. There are instances also where longitudes of the sun from two different instruments differ a second of arc for a number of years at a time—a quantity the size of fluctuation. There are small discordances between occultation and meridian observations of the moon. Much of the dif-

ference between theory and observation in the longitude of the moon is attributed to fluctuation in the earth's rotation. This follows no formula, and it can be determined only by continuous and uniform observation. Dr. Ross found a lack of observational material for his work on Mars. He also called attention to large systematic differences between mean results from different instruments, and expressed the opinion that more accurate positions than are now available are necessary for proper determination of fluctuation. Positions of the equator and the equinox from different series may differ a third of a second of arc.

Continuous observations of this nature are now being carried on at three observatories, Greenwich, Washington and the Cape, with shorter series at Pulkowa and elsewhere. There is clearly a need for another such series. For this the instrument should be in the southern hemisphere, south of 40° south latitude, so as to permit a satisfactory solution for the pole. To insure continuity and permanency it should be under government supervision. I believe it would be of great help to observational astronomy of to-day, and of lasting benefit to astronomy in the future, to establish another series of continuous observations of the sun, moon and planets and standard stars in the southern hemisphere.

And finally a word may be said as to future reductions and theory. The new fundamental catalogues will require new systematic corrections to all the 600 catalogues of the past, with corresponding changes, averaging 0″.2 or 0″.3, in all centennial proper motions. Present programs are furnishing large amounts of material for determination of proper motions, and these will need to be discussed for general motions in space and for a new value of the precession constant. Theoretically, Newtonian dynamics define precession, but the constants of the earth-moon-sun system entering into it are not sufficiently determined to give a complete solution. In fact, the best value of the ellipticity of the figure of the earth is determined from the observed precession. The precession is therefore determined by combination of theory and observation. The best determinations at present are based on the observed motions of some 6,000 of the brighter stars, but better material, and a much larger amount, will soon be available for discussion of this important constant. It is complicated by the motions of the comparison stars, including a possible galactic rotation of 1″, and by dynamical relations in the solar system, including also a relativity effect of 2″.

The present planetary and lunar tables are very accurate, and with minor corrections will be sufficient for a long time. They depend largely upon observations in the last century during which astronomical time gained continuously on uniform time. Planetary motions should represent uniform time if it is found possible to define such time. The knowledge of the geophysics of the earth is so limited that tidal retardation can not be accurately computed, nor can fluctuation be predicted. The fluctuations in the longitudes of the sun and moon are not well correlated. Observations in declination as well as in right ascension should be discussed for the longitudes. The difference between theory and observation of the moon is now 16″. The correlated residual for Mercury is 6″, but observations give 3″. There is a similar discrepancy about the year 1785.

Planetary tables include sufficient terms in adopted theoretical expansions to give tabular positions within 1″. Single observed positions approximate this, and normal positions are considerably more accurate. It may be possible, therefore, now to determine more exact coefficients in the expansions and to include higher terms. Residuals of 5″ in the longitude of Neptune, which has been observed but part way around its orbit, may be satisfied by simple changes in its elements. There are residuals in longitude for several of the other planets. Pluto suggests expansion in planetary theories, and the asteroids and satellites constantly furnish new and interesting problems. The mass of Mercury is uncertain, and the meridian observations of this planet need further discussion. The secular motion of the perihelion given by observation is uncertain by a number of seconds, the transits and the meridian results being discordant. The theoretical motion has been computed five times with a range of 3″, using the same masses of the disturbing planets. The mass of Venus is uncertain by one part in a hundred, and this leads to uncertainties in the periodic and secular terms in other planets depending upon this mass, such as the secular variation in the obliquity for which discordant results are obtained, and an uncertainty of 3″ in the motion of Mercury's perihelion. There are rather large residuals in the observations of Mercury and Venus near inferior conjunction.

The observations of the moon need to be corrected for irregularities of the limbs, and the residuals in latitude and longitude require further study.

There is some question as to the value of the aberration deduced from latitude work. The visual and photographic zenith results give discordant values of this constant, but very accurate values of the constant of nutation. To avoid confusion it would seem best not to change the fundamental constants now in use, except the equinox, until a complete new adjustment can be made. These problems have been suggested by

the observations, and there are many others awaiting investigation.

Some 40,000 observations of the sun, moon and planets have accumulated in the 40 years since the construction of the present tables. This great mass of observational material has nearly as much weight as that used in the tables. It is as yet largely undiscussed. There are also some older series needing rediscussion.

Modern calculating machines are becoming very valuable for carrying out the long numerical operations required in such computations, and with a minimum of labor and a maximum of efficiency.

Contributions to astronomy from endowment funds have been generous. The great Albany catalogue, just being completed by the Carnegie Institution of Washington, will be of great value to astronomers. The results from Mt. Wilson are inestimable. Many important investigations have been made possible by grants from various research funds, and much more support is desirable.

The present generation has had many men of outstanding ability in this work who are passing on a heritage to the younger men of to-day. It is an open and inviting field for investigation. In our classrooms and observatories there may be young men with special talent for such work. I know of no greater help to astronomy nor of any more profitable use of endowment funds than that those who are directing larger astronomical activities should make provision for men of marked ability to study with theoretical men and at fundamental observatories, and later, furnished with assistants and facilities, to make a complete discussion of all observations into a new and comprehensive solution of planetary motions.

I leave with you the suggestion that a more complete solution of the motions in the solar system is now an important problem in fundamental astronomy.

OBITUARY

JESSE EARL HYDE

JESSE EARL HYDE, professor of geology at Western Reserve University, Cleveland, Ohio, died on July 3, 1936. He was born on May 2, 1884, in Rushville, Ohio, the son of Eber and Flora (Johnson) Hyde. He passed his boyhood in Lancaster and attended Ohio State University, graduating in 1906. He held minor positions in Harvard and Columbia Universities and became assistant professor of geology in Queen's University, Kingston, Canada, in 1911. From this position he was called to Western Reserve University as associate professor in 1915, becoming professor after the death of Professor Cushing in 1921.

The father of Professor Hyde was a pharmacist by profession and a geologist by avocation. There was built an annex to the family home, a room devoted to collections and work in geology, and in this room Jesse spent most of his boyhood leisure. During those years and later there were collected thousands of specimens, and these are now in the possession of Western Reserve University.

A discussion of Hyde's work and influence during his Cleveland years falls somewhat naturally into certain categories. The first to be discussed is his interest as a teacher, one might say also, as a conversationalist. In all his personal contacts he promptly struck a responsive strain, and when he spoke, no one, in his class or outside, failed to give him attention. Probably his most stimulating teaching was in the course called "Evolution of the Earth and the Ascent of Man." These class lectures were so inspiring that a number of his colleagues joined themselves to his listeners. His fund of experience, his philosophical interpretations and his manner of approach were such that his auditors received a stimulus which was high above the ordinary classroom type.

In 1922 Professor Hyde became formally associated with the Cleveland Museum of Natural History, then in its early stages. He was curator of geology until his health in 1931 required the severance of the more formal connection. However, he continued in the capacity of adviser and volunteer curator after that date. The work of those years was three-fold. He left the entire geological collection completely labelled, catalogued and arranged as a study collection. He directed the collection of fossil fishes, and the Cleveland Museum now possesses the best collection in existence of Devonian fish in the Cleveland shales. He was justly proud of the J. H. Wade gem collection which he arranged, a laborious and rewarding piece of work. It has been called the best exhibited gem collection in America.

He worked many summers under the Ohio State Geological Survey. His work on the Waverly Formation is of considerable magnitude, but has not yet been published. The "Camp Sherman Quadrangle" (Geological Survey of Ohio) is a monograph of 185 pages. About fifteen other publications are of lesser size. He was on the Geological Society of America Exchange Committee, in charge of the exchange, distribution and deposition of geological publications from all over the world.

Professor Hyde often deplored the sacrifices he made in attending committee meetings in the adminis-

tration of his democratic university. He was called upon incessantly and was a most patient and useful counselor. It is only natural to assume that his misgivings in devoting so much time to this type of work were assuaged by his feeling that he was helpful, and he surely had some interest in this type of intellectual activity. His sense of duty was no doubt an important factor.

To an outside observer Professor Hyde's academic career may have seemed of about the same nature of that of the usual college professor, more successful in some respects, less so perhaps in others. Only a few were familiar with a less apparent versatility which when fully realized marked him as unusual. There was in him a strain of the artistic and an even more striking strain of the philosophical. In the former connection he was especially interested in the use of lines. He studied intensively available types of drawings and etchings, partly from an inherent interest, partly to enable him to produce with the desired degree of satisfaction the graphic representations of his work. The drawings in his work on the Waverly Formation illustrate his success in such portrayals.

To a few he directly revealed his philosophical bent. Others appreciated this from his lectures and his conversation. Practical results of this bent are seen in some of his informal essays, in his annotations in his books, his lectures, the conferences he held with students in discussing their religious problems. However his intense devotion to these fields of thought, revealed more clearly after his death, comes as a surprise to some even who knew him well.

Especially noteworthy among his interests was book collecting. One lot, collected no doubt with a sense of humor, he called his "monkey books," a lot of specious undisciplined writings aimed at evolution. A serious and larger collection includes books which he used to clarify his ideas not on what one might call "Conflict of Science and Theology," but rather on the consonance of scientific and spiritual interests. His most valuable collection is an outstanding set of biographies and autobiographies of scientists and naturalists.

Hippolyte Gruener

RECENT DEATHS AND MEMORIALS

Professor Stanley Rossiter Benedict, for many years head of the department of biochemistry at Cornell University Medical College, died suddenly on December 21. He was fifty-two years old.

Dr. Marshall Avery Howe, director of the New York Botanical Garden, died on December 24 at the age of sixty-nine years.

William Campbell, professor of metallurgy at Columbia University, died suddenly on December 16 at the age of sixty years.

Dr. J. K. Fotheringham, reader in ancient astronomy and chronology in the University of Oxford and honorary assistant in the University Observatory since 1925, died at Dumbarrow on December 12 at the age of sixty-two years.

John Nicholas Vrooman Vedder, professor of thermodynamics at Union College, Schenectady, N. Y., died on December 26. He was sixty-three years old.

A portrait of the late Charles Proteus Steinmetz, of the General Electric Company, was unveiled on December 14 in the assembly hall of the Steinmetz High School, Chicago. The portrait is the gift of the General Electric Company. It was accepted on behalf of the school by Mayor Kelly and by Principal D. F. O'Hearn.

According to a wireless dispatch to *The New York Times*, the twenty-fifth anniversary of Roald Amundsen's discovery of the South Pole was marked on December 14 by a meeting in the polar museum aboard Dr. Fridtjof Nansen's vessel *Fram*, in which tablets were unveiled in memory of Nansen and Captain Otto Sverdrup by Knud Ringnes, chairman of the *Fram* committee, and in memory of Amundsen by Knut Doaaas.

SCIENTIFIC EVENTS

THE BRITISH COMMONWEALTH SCIENTIFIC CONFERENCE

The British Commonwealth Scientific Conference met recently in London, under the chairmanship of Sir Charles Howell Thomas. The London *Times* reports that the commonwealth delegates were impressed by the effectiveness of the system administered by the executive council of the Imperial Agricultural Bureaux and favored the continuance and the extension of this system.

In his address Sir Charles pointed out that after having been on trial for seven years this cooperative commonwealth scheme may be said to be firmly established on a permanent basis, and that it shows "two main factors which underlie successful inter-imperial scientific cooperation. One is that the objective must be clearly defined, strictly limited in scope and of a nature which appeals to all units of the commonwealth. The second is that the executive body must owe allegiance to no particular government, but be strictly rep-

sentative of all and constituted on a basis of complete equality. Clearly in such a case every decision taken must be unanimous; there can be no question of voting, for no scheme could proceed with any prospect of success if there were even one dissentient."

He continued:

The present work of the Imperial Agricultural Bureaux aims at keeping research workers in close touch with all that is going on throughout the world in their respective fields of science. The course of scientific work in the sciences related to agriculture is proceeding so rapidly that such an information service is essential. The service incidentally is available on payment to workers outside the Empire.

The information side of the council's work is financed strictly on the principle laid down by the Imperial Committee on Economic Cooperation and Consultation. The executive council has other duties in which Commonwealth Governments are interested. One in particular affords an example of a scientific activity in which all Commonwealth Governments are either actually or potentially interested, and which is therefore peculiarly suitable for inter-Imperial treatment. This is the parasite laboratory established at Farnham Royal, Slough, to study and distribute throughout the Empire the insect parasites which attack injurious insects and noxious weeds. Certain Dominions are making more use than others of its services at the moment, but all realize the potential value of the work. Hence all are concerned to preserve intact the basic staff, while the individual requests for help can be dealt with on the basis of payment for services rendered.

To a less extent the same principle applies in the case of the Institutes of Entomology and Mycology, dealing respectively with insects and fungi. Their work is partly information in providing plant pathologists throughout the Empire with summarised accounts of the progress of scientific development, and partly the identification of specimens submitted. The extent to which the various Dominions and Colonies benefit from this service determines the contributions made towards its maintenance. Finally, the executive council provides an avenue through which certain Dominions may contribute to research projects in which they are specially interested, such as wool research at Torridon, Leeds, and low temperature storage and transport research at Cambridge and the Ditton laboratory.

NEW ADDITION TO VANDERBILT UNIVERSITY HOSPITAL AND MEDICAL SCHOOL

THE new addition to the Hospital and Medical School of Vanderbilt University, which is now under construction and will be completed by the autumn of 1937, will provide an increase of about 1,500,000 cubic feet to the present medical building. This is expected to add greatly to the efficiency and range of service in the University Hospital. Facilities of the Medical School will be increased also and better adapted to the needs of medical education. This development has been made possible by the donation of $2,500,000 from the General Education Board of the Rockefeller Foundation. Of this amount about $950,000 will be expended on the equipment and building.

This gift affords facilities for improving the teaching, especially in obstetrics and gynecology and pediatrics. An increased number of beds will be provided and the laboratory facilities will likewise be increased for research.

There will be 155 additional beds in the new addition, which will mean, including those in the present building, a total number of about 375 beds. Of this number as many as 90 beds will be used for private and semi-private patients. There will be about 40 beds for teaching pediatrics and 30 beds for clinical instruction in obstetrics. A ward will be provided also for gynecology, including 18 beds.

The Out-patient Service will be enlarged so as to provide special quarters for obstetrics and gynecology and pediatrics. The Department of Radiology will be moved to the second floor level in the south end of the new addition. This will afford increased space and better equipment for this service. The Department of Preventive Medicine and Public Health will be moved into the north wing of the new addition, and the rooms now occupied by this department will, in large measure, be used for the extension of the stock room of the Medical Library. This will make it possible to enlarge the reading room of the library.

THE ASIATIC PRIMATE EXPEDITION

INVESTIGATORS from Harvard University, Bard College and the Johns Hopkins University, according to an announcement in *The Harvard Alumni Bulletin*, left at the end of December for Siam, Borneo and Sumatra in order to study the Asiatic anthropoid apes, especially the gibbon, in their native forests. Others will start in January.

Harold J. Coolidge, Jr., assistant curator of mammals at the Harvard Museum of Comparative Zoology, who has made many studies of anthropoid apes, leads the group. The other members are: Dr. Adolph H. Schultz, associate professor of physical anthropology at the Johns Hopkins School of Medicine, primate morphologist; Dr. C. R. Carpenter, lecturer in psychology at Bard College, who has made studies of the social life of monkeys in Central America; Sherwood L. Washburn, who holds a Sheldon traveling fellowship in anthropology; John A. Griswold, Jr., research assistant in the Harvard Museum of Comparative Zoology; Andrew Wylie, of Washington, D. C., special assistant for the collecting of large mammals, and John T. Coolidge, Jr., of Milton, Mass., artist and photographer.

Some members of the expedition sailed from New

York for Singapore on December 29 on the *Kota Tjandi;* the others will go from Vancouver on the *Empress of Japan* on January 9. The two groups will connect at Singapore and proceed thence by rail, by way of Bangkok, to Chiengmai in northern Siam, where a camp will be established from which Dr. Carpenter will study for three or four months the social life of the gibbon.

Early in May, the whole expedition, except Dr. Carpenter, will go to British North Borneo. One group, using Jesselton as a base, will make collections on the higher slopes of Mt. Kinabalu, and the other, using Sandaken as a base of supplies, will make studies and collections in the lowland forest on the east coast of the island. The North Borneo investigation will terminate in August so that certain members of the expedition may return to the United States in time to resume their college work in the autumn.

In July, when the rainy season begins in northern Siam, Dr. Carpenter will move his camp to the mountains of northern Sumatra, where Harold J. Coolidge will later join him; they will make studies of the orang-utan. At the conclusion of the work in north Borneo, Mr. Coolidge will spend a month in Java and another in Sumatra making a survey of wild life; that study is sponsored by the American Committee for International Wild Life Protection and will be supported by a special grant from the Bureau of International Research of Harvard University and Radcliffe College.

The project as a whole will be known as the Asiatic Primate Expedition. It will be financed by the Carnegie Institution, the Columbia University Council for Research in the Social Sciences, the Milton Fund at Harvard, and also by private donations.

THE SECOND INTERNATIONAL TESTING CONGRESS

At its first congress, held in Zurich in September, 1931, the International Association for Testing Materials has, according to the *Bulletin* of the American Society for Testing Materials, accepted an invitation from the committee representing British members to hold the next congress in Great Britain, and recently the permanent international committee approved the suggestion that the congress be held in London from April 19 to 24, 1937.

The object of the congresses held by the International Association for Testing Materials is to obtain international cooperation in the study of materials and their testing and to provide facilities for the exchange of views, experience and knowledge with regard to all matters connected with this subject.

The proceedings will be based on selected papers, which, by invitation, have been contributed by leading authorities in their respective fields throughout the world. Most of these invitations have been issued, and approximately 150 papers have been promised. Some twenty-two papers to be presented at the congress will be prepared by American authors. Matters in connection with American participation are being directed by W. H. Fulweiler, representative on the permanent committee. The organization of the congress has been undertaken by a congress organizing and reception committee, which consists of the British committee and representatives of many leading British institutions.

The subjects selected for discussion are divided into four groups dealing respectively with metals, inorganic materials, organic materials and subjects of general importance. The following subdivisions have been made:

Group A—Metals: (1) Behavior of metals (mechanical and chemical) as dependent upon temperature, particularly in regard to high temperatures; (2) progress of metallography; (3) light metals and their alloys; (4) wear and machinability.

Group B—Inorganic Materials: (1) Concrete and reinforced concrete; (2) erosion and corrosion of natural and artificial stone; (3) methods of testing ceramic bodies.

Group C—Organic Materials: (1) Textiles; (2) wood cellulose; (3) timber preservation; (4) aging of organic materials; (5) colors and varnishes.

Group D—Subjects of General Importance: (1) Relation between the results of laboratory tests and behavior in use and service; (2) the bearing of recent advances in physics and chemistry on the knowledge of materials; (3) the properties of materials for the thermal and acoustic insulation of buildings.

A Congress Book will be issued, which will contain, in addition to the papers presented, an account of the proceedings, articles by each of the four group presidents, in which attention will be directed to the principal additions to knowledge recorded in the papers and discussions. The papers as presented will generally not exceed 1,000 words each in length. They will be printed in English, French or German, in which languages the proceedings of the congress will be mainly conducted.

In addition to the technical sessions of the congress, numerous visits to places of scientific and industrial interest will be arranged, as well as excursions and social functions, including a banquet, a dance and official receptions.

Detailed information will be issued in due course. All requests for further information and inquiries should be addressed to the Honorary Secretary of the Congress, Mr. K. Headlam-Morley, at the offices of the British International Association for Testing Materials Committee, 28 Victoria St., London, S. W. 1. Sir Frank Smith, secretary of the Royal Society of Great

Britain and secretary of the Department of Scientific and Industrial Research, is chairman of the executive committee on the congress organizing committee, and Dr. H. J. Gough, superintendent, Engineering Department, National Physical Laboratory, is chairman of the British International Association for Testing Materials committee.

A NEW SOIL SCIENCE SOCIETY

AT a joint meeting of the Soils Section of the American Society of Agronomy and of the American Soil Survey Association in Washington, D. C., in late November, these organizations voted to merge and form the Soil Science Society of America. The object of the new society is to foster all phases of soil science. Sections have been organized in soil physics, soil chemistry, soil microbiology, soil fertility, soil morphology, classification and cartography and soil technology. A close affiliation with the American Society of Agronomy will be maintained. The papers presented at the annual meeting will be published in a volume of *Proceedings*. This volume will supersede the annual *Bulletin* of the American Soil Survey Association. The society elected the following officers:

President, Richard Bradfield, the Ohio State University, Columbus, Ohio.

Secretary and Vice-President, A. M. O'Neal, Sugar Cane Soil Laboratory, Houma, La.

Secretary-Treasurer, P. E. Brown, Department of Soils, Iowa State College, Ames, Iowa.

Chairmen of the various Sections:

I. Soil Physics, H. E. Middleton, Division of Research, Soil Conservation Service, Washington, D. C.
II. Soil Chemistry, S. F. Thornton, Purdue Agriculture Experiment Station, Lafayette, Ind.
III. Soil Microbiology, L. M. Turk, Department of Soils, Michigan State College, East Lansing.
IV. Soil Fertility, W. H. Pierre, Department of Agronomy, West Virginia Agricultural Experiment Station, Morgantown.
V. Soil Morphology, Classification and Cartography, L. C. Wheeting, Department of Agronomy, Washington State College, Pullman, Wash.
VI. Soil Technology, L. R. Schoenmann, Department of Land Use, University of Michigan.

SCIENTIFIC NOTES AND NEWS

As has already been announced in SCIENCE, the annual meeting of the British Association will be held next year in Nottingham from September 1 to 8, under the presidency of Sir Edward Poulton. Presidents of the sections have been elected as follows: Section A (Mathematical and Physical Sciences), Dr. G. W. C. Kaye; B (Chemistry), Dr. F. L. Pyman; C (Geology), Professor L. J. Wills; D (Zoology), Professor F. A. E. Crew; E (Geography), Professor C. B. Fawcett; F (Economics), Professor P. Sargant Florence; G (Engineering), Sir Alexander Gibb; H (Anthropology), Dr. J. H. Hutton; I (Physiology), Dr. E. P. Poulton; J (Psychology), Dr. Mary Collins; K (Botany), Professor E. J. Salisbury; L (Education), H. G. Wells; M (Agriculture), J. M. Caie.

THE Penrose Medal of the Geological Society of America for 1936 was presented on December 30 to Dr. Arthur Philemon Coleman, professor of geology emeritus at the University of Toronto. The award is made "in recognition of eminent research in pure geology and of outstanding original contributions of achievements which mark a decided advance in the science of geology."

DR. RICHARD E. SHOPE, of the department of animal and plant pathology of the Rockefeller Institute for Medical Research at Princeton, N. J., has been awarded the John Phillips Memorial Medal for the year 1937 by the American College of Physicians.

THE New York Academy of Sciences has awarded the A. Cressy Morrison prize of $250 to Dr. Albert F. Blakeslee, A. Dorothy Bergner and Amos G. Avery, of the department of genetics, Carnegie Institution of Washington, Cold Spring Harbor, L. I., for their paper on "The Geographical Distribution of Chromosomal Prime Types of the Jimson Weed." The second prize of $150 has been awarded to Dr. Frederick Fey Sheldon, of the University of California, for his paper on "The Bones, Muscles and Probable Evolution of the Catfish and Related Species."

THE American Institute, New York City, has made the following awards: A fellowship to Watson Davis, director of Science Service, for "interpreting to the people of the nation the rapid progress of science upon which modern civilization depends and for the organized dissemination of research findings as news"; a gold medal to the Bell Telephone Laboratories for "researches in electrical science which, applied to communication, have promoted understanding, security and commerce among people by transmitting human thought instantly throughout the world."

AT the one hundred and eighteenth annual meeting of the New York Academy of Sciences, Dr. George H. Sherwood, educational director of the American Museum of Natural History, was reelected honorary president. Honorary members were elected as follows: Professor K. S. Lashley, of Harvard University; Pro-

fessor Henri Breuil, of the College of France; Dr. Julian S. Huxley, of the Zoological Park, London; Dr. Aleš Hrdlička, of the U. S. National Museum; Dr. Alfred Cort Haddon, of Christ's College, University of Cambridge; Sir Arthur William Hill, director of the Royal Botanic Gardens, Kew, and Professors Maurice Caullery and Octave Duboscq, of the Sorbonne.

SIR ROBERT MOND has been elected an associate foreign member of the Académie des Inscriptions et Belles Lettres in Paris, in succession to the late King Fuad of Egypt.

PROFESSOR EMIL ABDERHALDEN, director of the Physiological Institute at Halle, has been elected an honorary member of the Cuban Society of Biology.

PROFESSOR FRIEDRICH ZAHN, president of the Bavarian Statistical Office, has been nominated president of the International Statistical Institute.

DR. HANS MOLISCH, professor of botany at the University of Vienna, celebrated his eightieth birthday on December 6.

DR. LANGLEY PORTER, a member of the faculty of the University of California for twenty years and dean of the Medical School for nine years, has consented to a rescinding of his recent retirement and will again assume the deanship, his reappointment to become effective immediately. This action was made necessary because of the sudden death of Dr. William McKim Marriott, who went from the deanship of Washington University Medical School to take Dr. Porter's place last July in conformance with retirement regulations. Dr. Porter will return to his post as an emergency measure with the understanding that efforts will be made to secure a new dean as soon as possible.

DR. HAROLD MESTRE has been appointed visiting associate professor and fellow in biophysics for the spring semester at Bard College, Columbia University, Annandale-on-Hudson, New York.

DR. E. G. ANDERSON, of the California Institute of Technology, will spend the period from December 15 to March 15 as visiting professor in the Division of Agronomy and Plant Genetics, University of Minnesota. Dr. Anderson is going to Minnesota in the absence of Dr. H. K. Hayes, temporarily on leave in China, to teach courses in advanced genetics, aid in the direction of seminars and assist with the genetics research program.

DR. WILLIAM H. TALIAFERRO, dean of the Division of the Biological Sciences of the University of Chicago Medical School, will spend the coming three months at the School of Tropical Medicine, at San Juan, Puerto Rico, conducting special research studies on the mechanism of immunity to trichiniasis. Dr. Lucy G. Taliaferro accompanies Dr. Taliaferro and is collaborating with him on this work, which is a joint project of the University of Chicago and the School of Tropical Medicine.

The Experimental Station Record reports that a laboratory for basic research in the biological and chemical problems of handling and processing citrus fruits and their products has been established by B. C. Skinner at Dunedin, Fla. Dr. R. B. Harvey, professor of plant physiology and botany at the Minnesota University and station, has been granted a year's leave of absence to take charge of the laboratory, which now has a staff of four coworkers. Attention will be given to improved methods of processing, utilization of cull citrus and other phases of citrus production and marketing.

DR. I. V. NEWMAN, who holds the Macleay fellowship of the Linnean Society of New South Wales and is known for his investigations of acacia, has been appointed lecturer in charge of botany at Victoria College, Wellington, New Zealand.

THE Faculty Committee on Research at Wesleyan University, of which Dr. T. A. Langlie is secretary, has made fourteen grants in various fields to members of the faculty. Those in science include the following: *Astronomy,* Professor Frederick Slocum, for assistance in computing work on photographic determination of the distances of stars and the measurement and reduction of photographs of the asteroid Eros; *Mathematics,* Professor Burton H. Camp, for computing aid in mathematical research; *Physics,* Professor Karl S. Van Dyke and Professor Walter G. Cady, for technical assistants to aid them in their work with piezo-electric resonators; *Psychology,* Associate Professor T. A. Langlie, for assistance in personnel research, with specific reference to Wesleyan University procedures with students; *Geology,* Assistant Professor Joe Webb Peoples, for the preparation of a monograph on the Stillwater Igneous Complex, Montana.

DR. RAYMOND W. WAGGONER, associate professor of neurology at the University of Michigan School of Medicine, has been appointed medical director of the State Psychopathic Hospital to succeed the late Dr. Albert M. Barrett, who was director for thirty years.

DR. JAMES SHELBY THOMAS, since 1933 president of the Clarkson College of Technology, Potsdam, N. Y., has been appointed head of the staff of the Chrysler Institute of Engineering. The institute was founded five years ago to permit graduate engineers in the engineering division to qualify for the master's degree. Since then it has been enlarged to include as under-

graduates other employees of the corporation. There are 1,000 students now enrolled.

THE address of Dr. G. E. Coghill, recently announced as Beaufort, N. C., is now Gainesville, Fla., where he expects to reside permanently.

DR. LEWIS H. WEED, professor of anatomy and director of the School of Medicine of the Johns Hopkins University, has been invited by the University of London to deliver the advanced course in anatomy. It is understood that he will lecture in London in the spring of 1937 and will choose for his subject "The Cerebrospinal Fluid."

DR. ARTHUR H. COMPTON, professor of physics, delivered the convocation address at the University of Chicago on December 15. The title of the address was "Can Science Point the Way?"

DR. RODNEY H. TRUE, chairman of the department of botany at the University of Pennsylvania, delivered a Sigma Xi lecture at the Massachusetts State College on December 7. He spoke on "Erosion."

DR. COLIN G. FINK, professor of electrochemistry at Columbia University, has planned a western trip during which he will speak before twenty local sections of the American Chemical Society, the American Institute of Mining Engineers and university groups on the following subjects: "Research in Electrochemistry," "Electrochemistry in Industry," "Corrosion" and "Chemistry in Art."

ERNEST H. ANTHES, director of the New York Division of the Bausch and Lomb Optical Company, visited the School of Tropical Medicine, San Juan, Puerto Rico, in December, where he lectured on the history of the microscope, its design and manufacture, with special reference to illumination methods.

THE annual Science Congress and Christmas lectures of the American Institute of the City of New York were held on December 28 and 29. The lecturers and their subjects were as follows: Dr. Harlow Shapley, director of the Harvard College Observatory, "Broadcasting from Antares"; Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry*, "New Man-made Materials," and G. Edward Pendray, secretary of the American Rocket Society, "Rocketing through Space."

A DINNER in honor of the British Association was given recently by the Technical Group of the Forum Club, London. Miss Caroline Haslett, director of the Electrical Association for Women, presided, and the chief guest was Sir Josiah Stamp, president of the British Association. Other speakers were Sir Edward Poulton, president-elect of the association, and Professor William Cramp.

AT the Paris Exposition of 1937, an International Congress of Physical Education and Sport will be held during the week beginning July 14. The National Committee of French Sports and the president of the committee of organization, Dr. Collect, will have charge of the program. The object of the congress is to interest the French medical profession in encouraging boys and girls to take up sports in a more active manner than is at present the case.

FOUR fellowships named in memory of the late Dr. Arthur D. Little, for many years a member of the corporation, have been announced by Dr. Harry M. Goodwin, dean of the Graduate School of the Massachusetts Institute of Technology. Two of the fellowships will be known as the Arthur D. Little post-doctorate fellowships, carrying stipends of $1,500 each, with facilities for research in the institute's laboratories. The other two are to be known as the Arthur D. Little fellowships and entitle their holders to stipends of $1,000. They are open to graduate students pursuing studies for the doctor's degree in the fields of chemistry and chemical engineering, respectively. The announcement was made in connection with the dedication of the industrial museum which has been established at the headquarters of the Arthur D. Little Company on the occasion of the fiftieth anniversary of this widely known research organization.

THE College of Mines and Metallurgy, a branch of the University of Texas, has been unanimously accepted as a member of the Association of Colleges and Secondary Schools of the Southern States. Membership of the College of Mines followed application made last year and an examining tour by a survey committee of the association, composed of M. C. Huntley, executive secretary of the association; D. M. Key, president of Millsaps College, Jackson, Miss., and Dr. B. Gould, Sophie Newcomb College, New Orleans, La.

DISCUSSION

THE EARTH'S CORE

ONE of the problems that has long puzzled seismologists is the nature of the earth's interior. That the earth is not a homogeneous body has long been known. The existence of a definite core some half the diameter of the earth seems well established. Reflected waves from this core and refracted waves through it seem to identify its existence beyond reasonable doubt. But what is the nature of the core? Is it solid liquid or gas? Let us see some of the conditions it must satisfy.

In density it must be such as to allow of a mean density of about 5.5 as concluded from the results of Boys and others. Accepting Gutenberg's radius of the core, this would seem to require (following Jeffreys) a core density of about 12 (crustal density 4.2). This comparatively high density of the core has led to the general view that it is metallic—iron, nickel and such substances being mentioned as possible constituents.

In the matter of rigidity, the core must be considerably less rigid than the shell if the total rigidity is to fit in with that demanded by tidal phenomena and the Eulerian nutation. Jeffreys suggests the zero rigidity of a liquid core.

In its behavior to shear waves it is difficult to say what conditions the core must satisfy. In view of the identification of core shear waves claimed by Macelwane, Krumbach, Imamura and Bastings, it seems that the core must be capable of transmitting a shear wave, but with considerable loss of energy as compared with the compressional wave. The compressional waves are quite prominent after passing through the core, whereas, apart from the isolated cases of identification mentioned above, the shear wave fails to appear.

In view of these required conditions, the picture of the core that most nearly suits our facts is a solid metallic core heavily occluded with some such gas as hydrogen. Experiments with palladium occluded with several hundred times its own volume of hydrogen have revealed effects on its elastic constants that point in this direction. Such a solid metallic sponge for core would seem to give the right values for density, rigidity and small shear wave energy. Experiments to determine the effect of occlusion on elastic properties and particularly on shear wave energy are being carried on. Their results will be published shortly.

JOSEPH LYNCH

FORDHAM UNIVERSITY

CELL INCLUSIONS AND THE LIFE CYCLE OF AZOTOBACTER CHROOCOCCUM

FOR some time the writer has been engaged in a study of the so-called life cycle of *Azotobacter chroococcum*. While these experiments have not been brought to completion, one point of particular significance may be recorded here. A search of the literature reveals the fact that much confusion exists concerning the nature of the granular bodies which are invariably present in the cells of *Azotobacter* at certain periods of growth.

Jones[1] noted two types of granules which differed from each other in staining capacity. Some of the granules were not stained by aqueous solutions of aniline dyes, while others became intensely stained. He regarded the stainable bodies as reproductive cells or gonidia. Löhnis and Smith[2] made similar observations and conclusions. Mencz[3] regarded the granules as a chromidial system and the equivalent of a true nucleus. Prazmowski[4] believed that each cell contains one nucleus which divides preceding cell division. Schmidt[5] reported the presence of volutin. There is no indication that any of the other workers performed microchemical or solubility tests to determine whether the stainable bodies are living entities of the cell or lifeless cell inclusions which function as reserve food. In the absence of precise knowledge concerning the true nature of the granular bodies, any theory as to their function must be doubted.

Experiments were performed, therefore, to determine the reactions which occur when standard tests for fat, volutin and glycogen are applied. The colorless granules are readily identified as fat bodies, while the stainable granules consist of volutin. It is obvious, *therefore, that these bodies could not perform the vital* functions assigned to them by previous writers. So far as this species is concerned there seems no support for the conception of a life cycle which involves reproduction by means of gonidia.

Additional work is in progress dealing with reproduction by symplasm, conjunction and endospore formation and the question of cell transmutation. The results of this study will be published elsewhere.

I. M. LEWIS

UNIVERSITY OF TEXAS

THE NEW AMERICAN DICTIONARY

NOTICE of publication by the University of Chicago Press of Part 1 of "A Dictionary of American English" has undoubtedly come to the attention of many American scientists, but perhaps few who have not actually seen the work are aware of its importance scientifically.

This dictionary, based on historical principles, is compiled under the editorship of Sir William Craigie, co-editor of the Oxford English Dictionary. In a letter I received from Professor Craigie in 1928, when the work of compilation had barely begun, he stated: "The New Dictionary will not aim at the inclusion of purely scientific terminology, but it ought to include the popular names of animals, birds, etc., so far as these can be historically traced." In this particular aspect the dictionary is succeeding admirably and

1 Dan H. Jones, *Jour. Bact.*, 5: 325, 1920.

2 F. Löhnis and N. R. Smith, *Jour. Agr. Res.*, 6: 675, 1916.

3 E. Mencz, *Arch. f. Protistenk.*, 22: 1, 1911.

4 A. Prazmowski, *Centralblt. f. Bakt.*, etc., II Abt., 33: 292, 1912.

5 E. W. Schmidt, *Centralblt. f. Bakt.*, etc., II Abt., 50: 44, 1920.

adequately, to a degree that should make the work a valuable addition to the scientist's library.

The dictionary, as its name implies, has to do primarily with words found to be indigenously American, and every word or sense of a word that originated within the present limits of the United States is conspicuously indicated as such. For instance, although the word *alkali* is found in English before 1600, there are three senses of the word listed as peculiarly American, as well as the expressions alkali desert, alkali dust, alkalied, alkali flat, alkali grass, alkali lake, alkali plain and alkali sink.

The thoroughness with which the vernacular names of American plants and animals are treated is illustrated especially under the word *American* itself, where no less than eighty biologic and ethnologic terms, ranging from *American antelope* to *Amerindian*, are given with their definitions and histories. For method of treatment let us quote one example:

+ **American chestnut.** The ordinary chestnut (*Castanea dentata*) of the United States. Also attrib. with *tree*.
1785 MARSHALL *Amer. Grove* 40 American Chesnut Tree. . . . The timber is used much for rails, splitting free and outlasting most of our Oaks. **1832** BROWNE *Sylva Amer.* 131 The American chesnut sometimes attains the height of 70 or 80 feet with a circumference of 15 or 16 feet. **1859** HILLHOUSE tr. *Michaux's Sylva* III. 12 Though the American Chestnut nearly resembles that of Europe in its general appearance, its foliage, its fruit, & the properties of its wood, it is treated by botanists as a distinct species. **1901** MOHR *Plant-life Ala.* 468 American Chestnut. . . . Important timber and nut tree.

The number of words purely American in origin is surprising; of these the following examples are selected to represent various branches of science and invention: *abalone, adobe, Alabama, alewife, amberjack, ambrotype, anaesthetic, ancon* (sheep), *angleworm, Appalachian, Arizona, Arkansas, automobile, Bad Lands.* Words originating after the end of the nineteenth century are not admitted to the dictionary.

For any one even only mildly interested in etymology or natural history or geography this dictionary makes good reading, as in fact any good dictionary does. Part 1 (A to Baggage) runs to 116 double-column quarto pages, and there are to be about 20 parts issued separately. By the time it is completed, judged from the beginning, the words of scientific import will mount to a considerable total.[1] It is to be hoped that scientific libraries, museums, and even individuals who can (Part 1 sells for $4) will avail themselves of this monumental reference work, the value of which is bound to increase as Americans become more and more aware of the richness of their own history and culture and put increasing store by the things that had their beginnings in their own country—the United States. In any event, the University of Chicago, the American Council of Learned Societies and the General Education Board of New York should be congratulated for sponsoring such a notable piece of literary research.

PAUL H. OEHSER

U. S. NATIONAL MUSEUM,
WASHINGTON, D. C.

SCIENTIFIC BOOKS

RECENT BOTANICAL BOOKS

The Story of the Plant Kingdom. By MERLE C. COULTER. ix + 270 pp. 119 figs. The University of Chicago Press, Chicago. 1935. $2.50.

MANY students still elect to go through a college course with very little training in science. This applies to certain pre-professional groups—such as those looking forward to law or journalism—who may be pressed for time; but it also holds for many who are not planning to enter such disciplines—the so-called "straight A.B.'s." In spite of the crowded programs and natural reluctance, the college graduate of this generation should live more richly if he has some understanding of the physical and natural sciences, along with the more traditional training in mathematics, the social sciences, the arts and the humanities. A remedy for the educational shortcoming that has thus existed is being tried in the survey courses that are now offered in some universities.

The text-book fruit of this type of course is beginning to mature; and it is to be expected that it will vary widely in different institutions. "The Story of the Plant Kingdom" is a volume that has been prepared for the "Introduction to the Biological Sciences," one of the courses of the "new plan" at the University of Chicago. We are told that the course in biology includes "indispensable readings" in ten books, of which this is one.

Nothing revolutionary has been attempted in this volume. The material presented is for the most part that which is included in the standard texts. Reversing the usual order, this book begins with a consideration of "primitive plants," especially the blue-green algae, and then traces the evolutionary development up through the algae, fungi, liverworts, mosses, ferns, horsetails, club mosses and seed plants. Only well on in the presentation are the structures and functions of the higher plants considered. There is a chapter on the process of evolution and a concluding chapter on some of the commoner families of the angiosperms.

Any book which treats the general subject of botany

[1] The prefatory note to Part 1 states: "In A, the largest group of words denoting actual things consists of the names of plants or trees and animals."

in a short space must omit or pass lightly by some of its aspects. If the volume under consideration is considered in its entirety—only twelve of the twenty chapters constitute "indispensable reading"—then relatively more emphasis than usual is placed upon the evolutionary development and life cycles of plants, and relatively less on the functions of the higher plants; very little attention is given to plant inheritance.

The book is written in simple, easily understandable, rather narrative style. The 119 figures are all original, and consist mostly of somewhat simplified, clear drawings and some good half-tone reproductions of photographs.

Those who come to their botany by way of "The Story of the Plant Kingdom" should gain an appreciation of the more classical and fundamental aspects of the science; they should be able to visualize the broad evolutionary panorama as it unfolded in ages past, and understand it; and they should acquire some insight into the nature and workings of the higher plants. They will not be burdened by a host of details, nor will they achieve the understanding and the pleasure that real intimacy engenders.

Botany: A Textbook for Colleges. By J. BEN HILL, LEE O. OVERHOLTS and HENRY W. POPP. xiii + 672 pp. 335 figs. McGraw-Hill Book Company, New York and London. 1936. $4.00.

THIS volume aims to present the material and interpretations of a two-semester college course in general botany. It gives an unusually comprehensive survey of the whole field of botanical science.

A general introduction is followed by a brief chapter on "Coloration in Plants," a feature which is so obvious in the autumn when most students begin their formal study. Otherwise the plan followed is similar to that of the majority of texts, the first half of the book being devoted to the structure and activities of the higher plants, the second half to evolutionary development. Inheritance is considered at the very end.

The organs of the seed plants are discussed in detail. In the chapter on the stem, for instance, in addition to the data usually presented on the external characteristics and the internal anatomy and development, the various types of bundles and of steles are described and figured. There are chapters each on "Food Synthesis," "Absorption of Water and Inorganic Salts," "Growth and Movement" and "Digestion, Respiration, Fermentation." There is hardly another general text in which one could find, for example, a discussion of photoperiodism, grand period of growth, presentation period, autonomic and paratonic movements, nasties and taxies.

The second part of the book, dealing with the divisions of the plant kingdom, similarly goes into considerable detail. Thus in the chapter on the gymnosperms, the Cycadofilicales, the Bennettitales, the Ginkgoales and the Gnetales are discussed, together with the more usual Cycadales and Coniferales; and among the last named some of the less commonly known genera, such as *Torreya* and *Agathis*, are mentioned and illustrated.

In the chapter on the "Families of Angiosperms" the authors have had the courage to depart from the sequence followed in the manuals; they discuss the dicotyledons before the monocotyledons. The buttercup and rose families are considered first in the dicotyledons, and the willow family last. The cat-tail family is taken up at the end of the monocotyledons.

Nearly all the abundant illustrations are original; this gives the volume a pleasantly new flavor. The style is simple, clear and not very animated. Summaries and bold-face type are used, with discretion, however, so that the reader has the privilege of doing some thinking for himself. The facts and interpretations are not presented dogmatically, and the whole field is portrayed as one that is still growing and expanding.

This book is no child's play. As a text to be used in a general elementary course, it is a tribute to the diligence of the authors and to the seriousness of the students for whom it is intended.

Practical Problems in Botany. By WILFRED W. ROBBINS and JEROME ISENBARGER. ix + 402 pp. 230 figs. John Wiley and Sons, New York. 1936. $2.00.

THIS volume is intended for use in a course in botany for "high school classes, especially if preceded by a course in general science or one in general biology." The authors aim to establish "a foundation of fundamental principles which will enable pupils to develop an understanding of the significance of plant life which is such an important part of their environment."

The text is composed of ten units, each introduced by its own preview; these ten divisions concern themselves with the organization and composition of plants, nutrition of green and non-green plants, growth, reproduction, dependence upon and adaptation to environment, the development, improvement, classification and economic importance of plants. Each of these units is then in turn subdivided into from four to ten "problems." The 63 problems thus outlined are treated in considerable detail, each with a thorough discussion. An unusually large amount of material is presented within these pages.

The outlook of the book is scientific, but economically significant and otherwise interesting features are

emphasized throughout. Thus some fifteen pages are devoted to a lucid discussion of artificial propagation in which stem, root and leaf cuttings, layering, suckers, runners and the various types of grafting are succinctly described. Similarly, the unit on the economic importance of plants to man deals with such mundane but nevertheless vital subjects as the various food plants from the cereals to the spices, beverage plants, fiber plants, wood, coal, cork, resins, turpentine, gums, dyes, oils, rubber, medicinal plants, weeds, poisonous plants and hay-fever plants. The evolutionary development of plants, while not overlooked, is not used as the theme of at least half the book, as is so frequently done in college texts.

The bulk of the book is devoted to the presentation of basic facts and principles. But those who are susceptible to mental stimulation will find ample opportunity for reflection in the 144 "exercises," many of which consist of several parts, the very numerous "additional questions and exercises" and the frequent "suggested activities." The well-chosen references will guide those who seek to go farther afield.

Paragraph headings and bold-face type are used extensively; but the style is not unpleasant nor is the reading difficult. The 230 figures, consisting of drawings and photographs, are simple and well selected; they are mostly original.

The student who has read, digested and assimilated the contents of this volume will have acquired a good grounding in the principles of botany; he will have learned many of the facts on which they are based; and he will have become acquainted with the humanly important applications of the science.

A Manual of Southern California Botany. By PHILIP A. MUNZ. xxxix + 642 pp. 310 figs. Claremont Colleges, Claremont, California. 1935. $5.00.

IT seems a little strange that despite the philosophical and penetrating analyses of Asa Gray our manuals should to this day be essentially compilations of descriptions of genera and species, coupled with brief notes on distribution and sometimes on time of flowering. Only with exceeding slowness have the challenging and important features of plant distribution been unravelling. This subject, to be sure, is still far from complete, but it has reached a stage at which it is now possible for students living in certain parts of the country to gain not merely a knowledge of the plants of their flora, but an understanding of that flora as well.

Those who live in southern California are especially fortunate in having in this volume an account of the development of their flora as well as the descriptions of the genera and species of which it is constituted. A discussion of some twelve pages is devoted to the distribution of the plants of southern California, in which such important geological changes as the submersion of large areas in the Eocene, Miocene and Pliocene, the glacial and interglacial conditions of the Pleistocene and the uplifts in the Tertiary are taken up. Next the physiographic features are considered; these include the Colorado and Mohave deserts, the various mountain regions, the "cismontane" areas and the islands. The characteristic plants of these regions are listed. The relationships with the north, with the Rockies, with deserts and the south and with islands are discussed; affinities with South America and the Mediterranean region are also mentioned. Throughout, the relatively high proportion of endemism is emphasized and explained on the basis of isolation.

Then follow a key to the families, and the descriptive flora, from the pteridophytes through the angiosperms. There are family and species keys, as usual. The family, genus and species descriptions are terse and sufficient. Brief ecological and distributional notes accompany the account of each species. Varietal differences are commonly given; it is possible to do this, since the volume deals with a relatively limited region. Three hundred and ten of the species are illustrated by well-drawn figures.

The botanically minded of southern California may rejoice in having both an authoritative and interpretive account of their own flora. Although less pretentious in its design than so many manuals, it gains by the familiarity with details that an intensive study of a more limited area alone makes possible.

An Illustrated Manual of Pacific Coast Trees. By HOWARD E. MCMINN and EVELYN MAINO. With lists of trees recommended for various uses on the Pacific Coast. By H. W. SHEPHERD. xii + 409 pp. 415 figs. University of California Press, Berkeley, California. 1935. $3.50.

ONE of the most discouraging features confronting those who aim to become acquainted with the plants of any fairly well-populated region is the distinction between "wild" and "cultivated" forms. This is the result, in part at least, of a certain inherent disdain with which the latter are treated by so many professional botanists. The "escapes" have tended to eliminate this barrier to some extent, but there are relatively few books that give both native and introduced plants together. In this regard the volume under consideration is a happy exception to the majority.

All the known species of trees, and some varieties native to California, Oregon, Washington and British Columbia are described—146 in all—together with some 400 introduced forms which have been planted as ornamentals in gardens and parks and along highways. These are grouped into families essentially

according to Engler and Prantl. The genera are keyed out largely on leaf characters. They are listed alphabetically in each family, each being discussed, and then the species are keyed. The species descriptions are brief but readable and give the outstanding characteristics in clear, concise fashion. A short note on distribution accompanies each account. There is nothing stifling about these species portrayals—in fact, they rather beckon.

The great majority of species are figured by exceptionally clear and rather artistic drawings of the leaves, in most cases of the fruits, and occasionally of the flowers. All the illustrations are original. The authors have shown good sense in making enlarged illustrations of the small leaves of such genera as *Callitris, Chamaecyparis, Cupressus, Juniperus, Libocedrus* and *Thuja*. Forms like *Dracena, Yucca, Musa* and the palms are effectively shown by photographs of the entire plant.

Such general topics as the leaf, flower, inflorescence, fruit and seed are discussed in a rather elementary way in the introduction. These are followed by a consideration of the origin and distribution of Pacific Coast trees, in which four sources are given: the subarctic and cool-temperate regions of the northern hemisphere, the arid Southwest and northern Mexico, the Great Basin and Rocky Mountain region and the Pacific Coast. The forms characteristic of each of these are listed. Because of the varied climate of the Pacific Coast, trees from the four corners of the earth have been introduced there—from the Himalayan region, various parts of Africa, Australia and New Zealand, as well as from Mexico, eastern and central United States and Canada. The climatic similarities between those regions and certain parts of the Pacific Coast, which have made their introduction there feasible, are elucidated.

The final pages of this volume are devoted to lists of trees recommended for various uses on the Pacific Coast. Intended primarily for the horticulturist, these lists include trees particularly desirable from such diverse standpoints as: alkali, drought and heat tolerance; autumn foliage; appropriateness in borders, hedges, lawns and avenues; erosion control; flower production; pest resistance; speed of growth; and numerous others.

The authors have produced a volume that may be considered a distinct contribution in many ways, especially because of its relative simplicity and ease of use, its broad scope and its uniformly excellent illustrations.

Krakatau, 1883–1933. *A. Botany.* By W. M. DOCTERS VAN LEEUWEN. xii + 506 pp. 10 figs. 36 plates. E. J. Brill, Leiden. 1936.

THIS volume summarizes and interprets the original work of a number of men, including the author, on the three volcanic islands of the Krakatau group, and especially of Krakatau itself.

The great eruption of Krakatau occurred in 1883, and so the present work presents the results of some fifty years of investigation. After a critical evaluation of the evidence, Docters van Leeuwen concludes that the vegetation was obliterated completely at that time. Situated between Java and Sumatra, the Krakatau group is consequently very favorable for ecological study. A comparison is made with more or less similar areas, such as Volcano Island, parts of Japan, Tarawara Mountain in New Zealand, Katmai in Alaska, and others. The botanical investigations of various collectors in Krakatau are then discussed, from the early ones of M. Treub in 1886 to the more recent ones in which the author was active.

The Cyanophyceae were "pioneers on the soil," and they were followed by mycorrhizal ferns. In 1886 eleven of the twenty-six species of vascular plants were ferns; in 1934 only fifty-two of two hundred seventy-one were pteridophytes, the majority of the remainder being dicotyledons. Four possible methods of distribution are suggested for these plants: wind, water, animals or man. It is estimated that the plants disseminated especially by wind contribute some 41 per cent. of the total of 271 species; approximately 28 per cent. were carried by water; some 25 per cent. were brought in various ways by animals; and about 15 species, or nearly 6 per cent., were brought in by man. These last, including some common weeds, did not thrive well.

One chapter is devoted to "Associations and Successions," in which grass associations, ferns, shore types and forests are considered.

In the last two hundred pages of the volume the galls that have been found on the islands—some of them are known only from Krakatau—and the various species of mosses, hepatics, pteridophytes and spermatophytes that have been collected are discussed. In some cases, for instance in the coconut, an extensive account of the adaptations for dispersal is presented.

The story of the vegetative recapture of these islands is graphically portrayed in the sixty photographs; those taken in 1928 and 1932 form a very striking contrast to those of 1886.

The book is a translation, and the style is not smooth. The whole work might gain in general interest if it were less polemic.

Docters van Leeuwen has made an important contribution to the botany of this unique and ecologically fascinating group of islands.

EDWIN B. MATZKE
SAM F. TRELEASE

COLUMBIA UNIVERSITY

ABSTRACTS OF PAPERS PRESENTED AT THE CHICAGO MEETING OF THE NATIONAL ACADEMY OF SCIENCES

Some recent advances in the theory of the calculus of variations: G. A. BLISS. Problems of the calculus of variations with variable end-points were considered early in the history of the subject. One of the first was that of finding, among the arcs joining two fixed curves, one down which a particle starting with a given initial velocity will fall in the shortest time under the action of gravity from one curve to the other. When the two fixed curves are replaced by two fixed points the problem is said to have fixed end-points. The case when both end-points are variable was studied by Lagrange in 1762. He made an error which he corrected in a paper of 1770, where he also formulated a much more general problem of the calculus of variations with variable end-points. Since that time the theory of problems with fixed end-points has been highly developed, but the theory of problems with variable end-points has lagged behind. In 1913 Bolza formulated a problem of the latter type which at present seems the most widely applicable. Recent papers by M. Morse and myself have brought the theory of this problem to a stage comparable with that of the theory of problems with fixed end-points. Important improvements were added by M. R. Hestenes while he was my research assistant and in later papers, and by L. M. Graves. Their results afford significant advances for the theory of problems with fixed end-points also, since they are deduced without the assumption of normality on sub-intervals customarily made by preceding writers, and apparently also without any assumptions of normality whatsoever. I have recently discovered, however, that on the basis of their hypotheses one can construct a problem for which the arc considered is normal, though not necessarily normal on sub-intervals, and by means of which the sufficiency theorems of Hestenes can be attained. Thus the normal case still appears to be the most important one. This is the result which I emphasize especially in this paper.

Remarkable results in additive number theory: L. E. DICKSON.

Polynomial approximation on a curve of the fourth degree: DUNHAM JACKSON. At a recent meeting of the American Mathematical Society the writer discussed the formal properties of polynomials in two real variables which are orthogonal on a curve in the plane of the variables. In the simplest cases, when the curve is a line segment or a circle, the resulting series developments reduce essentially to Legendre and Fourier series, respectively, so that in those cases new problems of convergence do not arise. The present paper is concerned with questions of the convergence of polynomial approximation on a particular curve of the fourth degree, for which the results are new in substance as well as in form.

Photoelectric guiding of astronomical telescopes: A. E. WHITFORD and G. E. KRON (introduced by Joel Stebbins). During long photographic exposures the astronomer must have his eye fixed at the eyepiece of a telescope in order to keep the instrument centered exactly on the object being photographed. The "automatic guider" in this paper delegates this tedious and exacting task to a photoelectric cell. The principal difficulty is the extremely small amount of light available to actuate the mechanism, so that the feeble impulse from a star must be amplified as much as a billion billion times. The use of the new Zworykin electron multiplier has made it possible to extend the working limit somewhat beyond that attainable by conventional methods of amplification. The control is exercised entirely through electron tubes, without mechanical relays. Preliminary tests on the 60-inch telescope of the Mount Wilson Observatory show that the device performs satisfactorily on stars down to about the eighth magnitude. The development of the new instrument is part of a program of research in connection with the 200-inch telescope of the California Institute of Technology.

The colors of stars in a region in Sagittarius: JOEL STEBBINS and ALBERT E. WHITFORD. With a photoelectric amplifier attached to the 60-inch telescope at Mount Wilson, measures of the brightness and color of seventy-five stars were made in a region about five degrees square in the constellation Sagittarius. Most of the stars are in a bright star cloud of the Milky Way, which is bordered by dark areas having the appearance of absorbing clouds of dust in space. Stars which shine through dense portions of the dust are found to be redder than stars out in the clear; the degree of reddening indicates the amount of dust between us and a star. The distances of stars can be measured by triangulation to two or three hundred light-years; farther than that the distances can be estimated by the apparent brightness of the stars. The stars here studied are two thousand light-years away. The region is toward the center of the galaxy, but the center is much farther, about 30,000 light-years, and no telescope will reach the center because of the obscuring dust. Even though this star cloud and others in the neighborhood appear as the brightest parts of the Milky Way, the measured reddening of stars shows that there is a thin veil of dust over this entire region of the sky, while in the opposite direction, away from the center of the galaxy, stars like those in Orion are white because we see them through much less dust.

The empirical mass luminosity relation: G. P. KUIPER (introduced by F. R. Moulton).

The 82-inch reflector of the McDonald Observatory: GEORGE W. MOFFITT (introduced by F. R. Moulton).

Solar activity recorded by the motion-picture method at the McMath-Hulbert Observatory of the University of Michigan: ROBERT R. MCMATH and EDISON PETTIT (introduced by Heber D. Curtis.) The new solar tower of the McMath-Hulbert Observatory of the University of Michigan is located at Lake Angelus, near Pontiac, Michi-

fat intravenously does not inhibit motility or secretion. This shows that the inhibition is not due to the absorption of the products of digestion of fat and sugar. (3) Appropriately made extracts of the mucosa of the upper intestine yield a substance which, when injected intravenously or subcutaneously, inhibit gastric secretion and motility, and which possess a number of the aspects of specificity. The steps in the proof remaining to be supplied are the chemical isolation of the substance and its identification in the blood or lymph. The substance has not been sufficiently concentrated to warrant its parenteral injection into a human subject. A unit of enterogastrone is that quantity, which when injected intravenously in a 12 to 14 kg dog with a pouch of the entire stomach and receiving sufficient histamine subcutaneously at 10-minute intervals to maintain a uniform flow of 1 cc of gastric juice (5 mg HCl) per minute, causes a 50 per cent. reduction in the secretion of hydrochloric acid during two hours following the injection of enterogastrone. Five one-hundredths of a unit will inhibit the movements of a stomach distended by a balloon containing 100 cc of air for about six minutes; one unit for about fifty minutes.

Mode of action of parathyroid extract on bone: FRANKLIN C. MCLEAN and WILLIAM BLOOM (introduced by A. J. Carlson). Very large doses (1,000 units) of parathyroid extract were administered to growing rats. Within six hours many of the osteoblasts died; the majority, however, changed into fibroblasts or osteoclasts, or became phagocytic. Within twelve hours a large proportion of the bone cells were necrotic, especially in the rapidly growing spongiosa of the long bones, and the number of osteoclasts had greatly increased by development from osteoblasts and reticular cells. Within twenty-four hours the necrotic bone tissue had been largely resorbed and replaced by scar tissue, containing a large number of osteoclasts, thus producing the typical picture of osteitis fibrosa generalisata. Recovery occurred by extensive intramembranous formation of new bone, accompanied by development of large numbers of active osteoblasts from the fibroblasts of the scar. These observations throw new light on the pathogenesis of experimental osteitis fibrosa, which appears to develop, in part at least, as a reaction to the death or injury of the cellular elements of bone. Of more general biological interest is the evidence that osteoblasts are not permanently differentiated cells, for they have been seen to change into phagocytes, osteoclasts and fibroblasts; further, fibroblasts have been seen to develop into osteoblasts which were then associated with the formation of new bone. This, then, is an example of controlled reversible cellular differentiation.

The mechanical efficiency of the heart as a measure of its fitness: M. B. VISSCHER (introduced by F. R. Lillie). In these studies, the oxygen consumption of the heart and the work performed by it were measured as described by Peters and Visscher. The dog's heart in the Starling Heart-Lung preparation was employed. Previous work, particularly by Starling and collaborators, has shown that the energy liberation with variations in load on the heart is determined by the length of the muscle fiber at the beginning of contraction. The fiber length is obviously determined by the volume of the ventricles of the heart, so it can be stated that volume of size of the heart at the end of diastole is the factor determining the liberation of energy in the succeeding contraction. Hearts were made to work for periods long enough to permit them to undergo acute failure and the quantities of energy liberated and work performed measured. The hearts were made to work at constant diastolic volume, that is, initial fiber length. Two important interrelated facts became apparent. First, as the heart became less able to perform work the energy output per contraction at uniform initial fiber length remained virtually constant. Obviously in this type of heart failure the defect is not a progressive inability of the muscle to liberate a normal quota of energy upon contraction. There is rather a failure on the part of the muscle in its ability to convert as large a fraction to useful work. Thus there was found to be an important decrease in the efficiency of heart muscle in the process of failure. The fact previously referred to, namely, that the heart automatically adapts itself to its load by increasing its volume and thus its energy liberation when it is unable to eject as much fluid per unit of time as enters it, necessitates that in order for a failing heart to carry a uniform load it must dilate. Thus a heart which must dilate greatly to perform a small load of work is an inefficient machine. In clinical terms such a heart is ordinarily described as having poor tone. In physical terms the tone of the heart muscle is shown by these studies to be in reality synonymous with its mechanical efficiency or its fitness to carry its load. In a further series of experiments the mechanism of action of certain cardiac drugs was investigated in relation to this question. It was found that the most useful glucosides of the digitalis series, employed in therapeutic doses (about 0.1 mgm per liter of blood) showed a prompt and large effect in restoring the efficiency of failing hearts toward the normal. It seems likely that these agents have their beneficial action through this mechanism. A new experimental criterion for the evaluation of cardiac drugs is available by the use of these methods.

The regulation of body temperature by the hypothalamus: S. W. RANSON (introduced by C. J. Herrick).

The rôle of stimulative and inhibitive induction in the development of primary and secondary sex characters: EMIL WITSCHI (introduced by F. R. Lillie). Previous studies showed that in the development of the vertebrate gonad the cortex acts as an inductor of ovarian differentiation and the medulla as an inductor of testicular differentiation. Thus sex is determined on the basis of a competition between two inductors, each of which stimulates differentiation of one sex and tends to prevent development of the other. New experiments on the nature of the inductors are presented which support the following conclusions: (1) Each inductor has a double function, stimulative and inhibitive. (2) Stimulative induction is transmitted from the inductor to the reacting tissues mainly by direct contact and therefore spreads only over a narrowly limited district. (3) Inhibitive induction has always a

wider range and in the extreme assumes the character of a typical hormonal reaction, transmitted by the blood stream. (4) It appears therefore that each inductor produces and releases at least two different inductive substances which are designated as *cortexin* + and *cortexin* – in the case of cortical products and *medullarin* + and *medullarin* – in the case of medullary products. (5) These inductive substances are not identical with the sex hormones of the mature sex glands which control the functional development of secondary sex characters.

Effect of galactic rotation on cosmic rays: ARTHUR H. COMPTON. Because of the rotation of the galaxy, the earth moves at about 300 km per second toward R.A. 20 h 40 m and declination 47° N. As a result of this motion, Dr. Getting and the author predicted a variation with sidereal time of about 0.1 per cent. (within a factor of 2) at 45° latitude and a difference of intensity between 45° N and 45° S latitude of about 0.5 per cent. During the past year the existence of a sidereal variation of the predicted amplitude and phase has been reported in the northern hemisphere by W. Illing, and in the southern hemisphere by B. F. J. Schonland and his collaborators. New measurements by R. N. Turner and the author provisionally confirm likewise the predicted difference between the northern and southern hemispheres. This quantitative confirmation of the predictions implies: (1) The astronomer's estimate of the rate and direction of galactic rotation is roughly confirmed, and no indication appears of a motion of the Milky Way as a unit relative to the source of cosmic rays. (2) The source of most of the cosmic rays is beyond our galaxy. (3) The agreement with prediction is satisfactory only if the cosmic rays are electrically charged particles.

Approximately relativistic equations for nuclear particles: G. BREIT (introduced by A. H. Compton). Cosmic ray showers indicate that at high energies the forces between protons and neutrons are intimately concerned with the creation and destruction of matter. Complete theories of the nucleus will, therefore, probably contain these phenomena as an integral part, and a full inclusion of the principle of relativity in the theory of the nucleus is presumably impossible without bringing in the electro-neutrino field or its equivalent. At present no satisfactory view of this kind is available. For most practical purposes it is nevertheless possible to form much simpler theories, including the effects of relativity and allowing one to compute the interactions between orbits and spins of nuclear particles. In this paper possible forms of such theories are enumerated. By means of them the fine structure of energy levels in the nucleus can be calculated. Comparison with experiment is made and is found to be satisfactory.

The intermediate product in nuclear reactions and disintegration in steps: WILLIAM D. HARKINS. (Read by title.)

Anisotropy in the atomic vibrations of zinc crystals as revealed by the scattering of x-rays: G. E. M. JAUNCEY (introduced by Joseph Erlanger). About a year ago Brindley and Spiers reported anomalous intensities for certain x-ray reflections at room temperature from powdered zinc crystals. These anomalous intensities indicated that the thermal vibrations of the atoms in a zinc crystal have larger amplitudes in the direction of the c-axis than in a direction perpendicular to this axis. Somewhat later Zener derived a theoretical formula for the mean square displacement in a direction ψ with the c-axis of a hexagonal crystal like zinc. This formula was immediately put to test in the author's laboratory. The method used was that of the diffuse scattering of x-rays from single large crystals. This method has the great advantage in this type of investigation that the mean displacement can be measured at a given angle of scattering for as many values of ψ as one desires. On the other hand, the powdered crystal method gives the mean displacement at a given angle of scattering for only one value of the angle ψ. We used Cinnamon's method for growing single crystals of zinc with different respective orientations ψ. We found that the root mean square displacements for liquid air and room temperatures are as shown in the table

ψ	100°K	298°K
0°	.103 A	.172 A
90°	.054 A	.093 A

These values are considerably larger than Zener's theoretical values. However, when Brindley and Spiers's anomalous reflection values are corrected for these thermal displacements they give values for the atomic structure factors of zinc which are those required by wave-mechanics when dispersion is taken into account.

The constitution of the borates: W. H. ZACHARIASEN (introduced by A. H. Compton). Through crystal structure determinations of several borates it has become possible to state some of the principles which govern the constitution of this class of substances: (1) Boron is either tetrahedrally surrounded by four oxygen atoms or triangularly by three oxygen atoms. (2) No oxygen atom is bonded to more than two boron atoms. (3) Not more than one oxygen atom is bonded to the same two boron atoms. Furthermore, the experimental work has led to accurate values for the interatomic distances and for the bond angles involved. A criterion can also be given which to some extent enables one to predict whether the coordination number for boron in a given case is three or four. The constitution of borates, particularly with reference to the polyborates, will be discussed on the basis of these principles. It will be shown how the glass-forming tendency of many borates can be explained from their constitution.

The ruling and testing of diffraction gratings: HENRY G. GALE (introduced by A. H. Compton). By greatly reducing friction in the new ruling engine at the Ryerson Physical Laboratory, we have succeeded in making diffraction gratings of very uniform spacing. It is now possible to study the effect of errors introduced automatically and to compare the resulting effects with those predicted by theory. A grating ruled with perfectly uniform spacing, a_0, will give in any order, N, a single sharp image of a monochromatic spectrum

line. If, however, the spacings, instead of being constant, vary sinusoidally with an amplitude a_1, and with a fixed period, false images appear on each side of the parent spectrum line. These false lines are called Rowland ghosts. Professor Rowland showed that the intensities of the parent line and of the 1st, 2nd, 3rd, etc., ghosts may be calculated from the Bessel functions of $(2 \pi N \frac{a_1}{a_0})$ of order zero, 1, 2, 3, etc., respectively. The new ruling engine performs so consistently that it has been possible to confirm Rowland's theory experimentally. An experimental comparison has also been made of the relative sensitiveness of knife-edge and interference tests of optical surfaces, and they have been found to be about equally sensitive. Both methods have been applied in testing concave and plane diffraction gratings. Knife-edge tests are very convenient and sensitive for testing the error of run in concave gratings, and interferometer tests are simple and convenient in testing the periodic error in plane gratings. Knife-edge tests may be used to detect departures from straightness in the rulings, when these departures are too minute to affect the definition. In ruling gratings on speculum metal, minute particles of speculum sometimes stick to the diamond point and cause it to fail to rule, often for a good many lines. This difficulty has been overcome for several years by covering the surface with a layer of oil a few millimeters thick. The oil keeps the diamond point washed clear of speculum particles.

Absorption spectra of the rare earths in crystals: Simon Freed and Raymond J. Mesirow (introduced by W. D. Harkins). The absorption spectra of salts of ytterbium (the chloride $YbCl_3 \cdot 6H_2O$, the acetate $Yb(C_2H_3O_2)_3 \cdot 4H_2O$ and the ethylsulfate $Yb(C_2H_5SO_4)_3 \cdot 9H_2O$) were found to resemble those of cerium very closely, especially in their diffuseness even at low temperatures. This is in marked contrast with the sharp spectra of the other rare earths. The resemblance was anticipated on the supposition that the 13 electrons in the 4f shell of Yb^{+++}, one short of the maximum the shell can hold, would give rise to but one term ^2F, the same term as the electron of Ce^{+++} in the same shell gives rise to. That is, activations aside from fine structure are impossible when the 13 electrons remain in the 4f shell. This prohibition is derived from the Pauli exclusion principle as it is applied to gases. The lattice, however, may possibly modify the application of this principle. It was thought likely that the activated states of these ions in crystals would respond to any change in the application of the principle the lattice might impose. The spectra show that the principle holds for these ions in crystals in exactly the same way as it does in gases. Strong confirmation is obtained that the sharp spectra of the other rare earths consist of "forbidden transitions," arising from a change in coupling among the electrons of the 4f shell.

Electronic structures of molecules: Robert S. Mulliken. Work of the writer on the electronic structures and spectra of molecules is illustrated by some examples. Comparing isoelectronic molecules, analogous energy levels and spectra can be traced, but the energy order and degree of degeneracy of the levels, and the locations of corresponding spectra, vary greatly with the symmetry and the chemical constitution. Among isoelectronic sets which have been studied are: N_2, CO, C_2H_2, HCN; B_2H_6, O_2, C_2H_4, CH_2O; F_2, H_2O_2, NH_2OH, N_2H_4, CH_3OH, CH_3NH_2, C_2H_6; CH_4, NH_4^+, NH_3, H_3O^+, OH; BeF_2, BOF, BO_2^-, NOF, NCO^-, CO_2, N_2O, N_3^+. Another type of comparison is between a molecule and its chemical homologues (*e.g.*, O_2, SO, S_2; or H_2CO, H_2CS); or between a molecule and its chemical derivatives (*e.g.*, C_2H_4, C_2H_3Cl, $C_2H_2Cl_2$, etc.; CH_4, CH_3Cl, CH_3Br, CH_3I, CH_2Cl_2, etc.; H_2CO, Cl_2CO, etc.). By making comparisons of these various kinds, including cross-comparisons, and trying to fit the available data into a (qualitative or partially quantitative) theoretical framework based on quantum mechanics, it has been possible to arrive at rather definite conclusions in many cases as to the natures of the electronic structures, energy levels and spectra, including continuous spectra. The results can be rather well expressed by assigning electron configurations to the various molecules and molecular states, and giving ionization energies for the various types of orbital (*i.e.*, one-electron orbital wave function) which appear in these configurations. Also, comparison of molecular ionization potentials with one another and with related atomic potentials gives information about charge-distribution or polarity in molecules (example, the $p\pi$ potential in I, HI, CH_3I, C_2H_5I, etc.).

(*To be continued*)

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THE ELECTRON: ITS INTELLECTUAL AND SOCIAL SIGNIFICANCE[1]

By Dr. KARL T. COMPTON
PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

WITHIN the past five years, centenaries, bicentenaries and tercentenaries have been much in vogue. Every town or institution or event which has claim to distinction has sought the excuse of the calendar to remind the world of its claims to greatness. Thus we have recently celebrated the centenary of Faraday's discovery of the principles of electromagnetism and the bicentenary of Watt's invention of the steam engine—discoveries which have introduced the eras of electricity and of mechanical power. The city of Chicago has reminded us that the progress of mankind really began with the founding of that community, and has led us to spend millions of dollars to gain the impression that there is really some causal relationship between Chicago and world progress. In my part of the country, the city of Boston and its suburbs staged a succession of tercentenary celebrations, as proud of their past as Chicago is of its present. Greatest of all was last summer's tercentenary celebration of Harvard University, signalizing the firm basis of intellectual freedom and leadership which is the prime requisite for a free people in a democracy.

Encouraged by the success of the Chicago Century of Progress and the Harvard Tercentenary, I venture to feature my address as signalizing an anniversary of the discovery of the electron. To be sure, it is only one generation old, and a generation is a sufficiently vague unit of time for my purposes. Yet, in spite of its youth, it bids fair to rival Chicago in its contributions to economic progress, and Harvard University in its contributions to the understanding of this world in which we live. So I venture to assert that no institu-

[1] Address of the retiring president of the American Association for the Advancement of Science, Atlantic City, evening of December 28, 1936.

tion or community, which has used one of these milestones to take stock of its achievements and plot its future course, has stronger claims to intellectual significance and practical utility than I will to-night claim for the electron.

The history of science abounds with instances when a new concept or discovery has led to tremendous advances into vast new fields of knowledge and art whose very existence had hitherto been unsuspected. The discoveries of Galileo, Faraday and Pasteur are such instances. But, to my notion, no such instance has been so dramatic as the discovery of the electron, the tiniest thing in the universe, which within one generation has transformed a stagnant science of physics, a descriptive science of chemistry and a sterile science of astronomy into dynamically developing sciences fraught with intellectual adventure, interrelating interpretations and practical values.

I take particular pleasure in mentioning these practical values, for even the most unimaginative and short-sighted, hard-headed, "practical" business man is forced to admit the justification for the pure research —of no preconceived practical use whatsoever in the minds of those who led in its prosecution and of all degrees of success and significance—which has been directed at the electron. For out of this research have come the following things which all can understand and appreciate: a growing business in manufacture of electronic devices which now amounts to fifty million dollars a year in America alone; a total business of some hundreds of millions of dollars a year which is made possible by these electronic devices; innumerable aids to health, safety and convenience, and an immense advance in our knowledge of the universe in which we live.

In science, as in human affairs, great events do not occur without a background of development. The electron had an ancestry which can be traced back through the centuries. Its immediate progenitors were the electromagnetic theory of light, spectroscopy and the leakage of electricity through gases. First cousins were x-rays and radioactivity and quantum theory, for, out of a background of long investigation of bewildering and apparently unrelated phenomena, there burst upon the scientific world the x-ray in 1895, radioactivity in 1896 and the electron in 1897—all while investigators in the older fields of heat radiation and thermodynamics were finding those bothersome inconsistencies in these hitherto respectable subjects which led to that unexpected extension of Newtonian mechanics which we now call quantum mechanics. The concept of the electron, behaving according to the laws of quantum mechanics, is now the basis of most of our interpretation of all that falls under the good old name of natural philosophy.

That only the pioneers of the scientific world were prepared for these discoveries, however, is witnessed by the fact that a standard text-book of chemistry widely used in my student days in 1904 stated that, "Atoms are the indivisible constituents of molecules," and as late as 1911 a prominent physicist warned his colleagues not to be too hasty in accepting these newfangled ideas.

The existence of electrons had been foreshadowed for a century by the facts of electrolysis which led Davy and Berzelius to conclude that chemical forces were electrical in nature, and Faraday to conclude that electrical charges exist only in multiples of some fundamental unit. For chemical acids and salts, dissolved in water, tend to split up into ions, *i.e.*, atoms or groups of atoms which move in an electric field in such directions as to indicate that they carry either positive or negative electric charges. Furthermore, it is found that the amounts of these ions which carry equal amounts of electricity are exactly proportional to the chemical combining weights of the ions. Faraday saw that this fact would be simply explained by assuming that every ion carries a charge proportional to its chemical valency, *i.e.*, the valency times a fundamental unit charge. But Faraday could not, from these facts, deduce the size of this unit of charge; he could only state the ratio of this charge to the mass of the chemical substance with which the charge was associated. Hydrogen, being the lightest of all ions, had of all known substances therefore the largest value of this ratio of charge to mass.

The first real evidence of particles of larger ratio of charge to mass than hydrogen ions came from the field of optics. Ever since Maxwell's equations of electromagnetism had predicted the existence of electromagnetic waves with the velocity of light, and Hertz, seventeen years later, had discovered them experimentally, physicists had felt sure that light must be caused by some sort of oscillations of electricity within atoms. But only the vaguest and most unsatisfactory speculations, such as whirling vortices or pulsating spheres of electricity, had been suggested.

In 1896, however, Zeeman tried the experiment of examining the spectrum of a light source placed in a strong magnetic field, and discovered that the spectrum lines thus became split into components of slightly differing wave-lengths, and that these components of the light showed characteristic types of polarization, depending on the direction in which the light emerged from the magnetic field. Almost at once, in January, 1897, Lorentz showed that this experiment proved that light is caused by the oscillation of electric charges, whose motions are affected by the magnetic field in the manner to explain Zeeman's experiments. This much was not unexpected, but what

was startling was Lorentz's proof that the Zeeman effect *could only* have been produced by electrified particles whose ratio of charge to mass is nearly two thousand times larger than that of a hydrogen ion, and whose mass is therefore presumably nearly two thousand times lighter than hydrogen.

Almost at once this conclusion was confirmed in a more dramatic and understandable way by J. J. Thomson, the then youthful director of the Cavendish Laboratory. But let me first pick up this thread of the story a little farther back.

All through the eighteen-eighties and early eighteen-nineties a series of most striking and unexpected discoveries followed from investigations of electric arcs, sparks and especially the glowing discharges of electricity at high voltages through glass tubes containing various gases at pressures far below atmospheric pressure. The striking color effects, mysterious luminous streamers and entirely bizarre behavior of these discharges made them the most popular, yet most elusive subject of laboratory research of those days.

It was these phenomena which led Crookes to postulate the existence of a mysterious "fourth state of matter," different from the solid, liquid or gaseous states. (Of course we now know that Crookes's fourth state is simply the ionized state of matter.)

Once, while attempting to photograph the appearance of a discharge at very low gas pressure, Crookes was bothered by the fact that all the photographic plates in the room with his apparatus became fogged, as if light-struck in spite of their opaque wrapping. He avoided the trouble subsequently, however, by keeping his new supply of plates in another room until, one at a time, they were wanted for use. Thus he solved an experimental difficulty and missed making a great discovery.

At about the same time Roentgen, in Germany, was trying the same experiment, and he too was troubled by the fogging of his photographic plates. But, as the story goes, his laboratory assistant called his attention to the peculiar fact that these fogged plates, when developed, showed the image of a bunch of keys which had accidentally been lying on top of the box of plates while the electric discharge experiments were in operation. Roentgen immediately looked into this and discovered that the fogging was due to penetrating radiations produced in the discharge tube where the cathode rays struck the target or anode. Thus by accident were x-rays discovered, that type of accident not uncommon in science when an observant experimenter is at work.

While on the subject of accidents, I might digress to tell of another accident which did not happen, also in connection with x-rays. For more than fifteen years after their discovery, disputes raged as to whether x-rays were radiations, like light but of very short wave-length, or electrically neutral particles of small mass and high speed. It was evident that they were not electrically charged, since their paths were unaffected by electric or magnetic fields. The leading advocate of the neutral particle theory was W. H. Bragg. In 1912, at Princeton, O. W. Richardson tried an experiment to see if x-rays could be refracted by a prism. A positive result would support the wave theory of x-rays. People had tried this with x-rays through glass prisms without success, but Richardson had a hunch that an iron prism might be more effective. So he passed x-rays for hours and days through the tapering edge of a Gillette safety razor blade, but without finding any refraction. If he had happened to try the edge of a crystal instead of the edge of the razor blade, he would undoubtedly have discovered the peculiar diffraction of x-rays in passing through crystals, discovered a couple of years later by Laue, Friederich and Knipping and developed by father and son, W. H. and W. L. Bragg, and which proved both the wave nature of x-rays and the atomic lattice structure of crystals. If Roentgen's discovery of x-rays was an accident, then I suppose Richardson's failure to discover diffraction of x-rays was a negative accident. I often wonder how many important negative accidents slip past us week by week!

But to get back on the subject of the electron, it was the cathode rays, which produce the x-rays, which finally turned out to be electrons traveling at high speeds. These cathode rays had been observed to shoot out in straight lines from the surfaces of cathodes in rarefied gases through which electric currents were forced by high voltage. Objects which they struck became luminous with fluorescent light, and objects in their paths cast shadows. But their true nature was disclosed when a magnet was placed near the discharge tube, for then their paths were curved in a direction showing that cathode rays were negatively charged.

By measuring this curvature produced by a magnetic field of known strength, and making a pretty sure assumption that the kinetic energy of these rays was determined by the voltage applied to the tube, J. J. Thomson in 1897 first showed that cathode rays are negatively charged particles with a ratio of charge to mass nearly two thousand times that of hydrogen. He furthermore showed that these particles are of the same type, as regards ratio of charge to mass, from whatever gas or cathode material they are produced. He therefore announced these particles, which he called "corpuscles," to be universal constituents of all substances. Thus was the electron discovered.

Quick and fast came experiments of ingenious design to study the electrons more accurately. They were pulled this way and that by electric and magnetic fields. They were caught in miniature metal fly traps,

called Faraday cages, to measure their charge and kinetic energy. They were detected in their paths electrically, or by photographic plates or by fluorescence. Continually refined from that day to this, we now know that an electron has a ratio of charge to mass which is about 1,842 times the similar ratio for a hydrogen atomic ion.

But it was very desirable to know separately the charge and the mass of an electron, and not just the ratio between these quantities. So an even more interesting lot of experiments has been carried on to measure the electron's charge. One of the papers on this week's program of the American Physical Society gives the latest results of such measurements. But they were begun back in about 1900 by J. J. Thomson and his colleagues, Townsend, H. A. Wilson and C. T. R. Wilson. I think a brief résumé of attempts to measure the electron's charge will throw an interesting sidelight on the versatility of scientific attack on a difficult problem.

The first attempts were by Townsend by measurements on the motion and electrification of fog produced when electrolytic gas was bubbled into a region of air which was slightly supersaturated with water vapor, but too many uncertainties were involved to make this work convincing. The first accepted results were by J. J. Thomson, who, after an earlier attempt, employed a technique of producing fog under controlled conditions, developed by his colleague, C. T. R. Wilson, and whose method was refined further by his pupil, H. A. Wilson.

It has long been known that water droplets of fog do not form in air which is somewhat supersaturated with water vapor unless there are nuclei, like specks of dust, on which the moisture can condense. Later Townsend found that fog will also condense on ions, and more readily on negative than on positive ions. C. T. R. Wilson designed an apparatus in which dust-free air could be supersaturated with moisture sufficiently to permit condensation of fog droplets on negative but not on positive ions, which were produced by some convenient ionizing agent. So a fog was formed, in which each droplet of water was condensed on a negative ion. Thomson employed this apparatus in the following manner.

Of course this fog gradually settled downward under the pull of gravity—slowly because the drops were small compared with the viscous resistance of the air through which they fell. It was like the slow settling of dust onto the furniture and floor of a room. But the theory of the rate at which spheres move when a force drives them through a viscous medium was already well known, due to Stokes's law. From this law, measurement of the rate of fall of the fog in centimeters per second as measured by a little telescope focused on the top edge of the fog, combined with knowledge of the force of gravity and the viscosity of air, enabled Thomson to calculate the size of the individual fog droplets. Dividing the total amount of water in the fog by the amount in one drop gave him the total number of fog droplets, and therefore the total number of negative ions. H. A. Wilson added the refinement of superposing an electric field on the gravitational field which pulled the drops through the air.

Then, as the fog settled to the bottom of the apparatus, it deposited its electric charge, which, altogether, was large enough to be measured with an electrometer. So, dividing this total charge by the number of ions composing it gave, as the charge of one ion, $3.4(10)^{-10}$ electrostatic units. This was the first real measurement of the charge of an electron, and was the value quoted in the tables of physical constants when I became a graduate student in 1910.

But about that time Millikan, who has always had a flair for picking strategically important subjects to which to devote his investigative talents, undertook with his students a revaluation of the electronic charge. Sources of error in the fog method were well recognized: fog droplets were not all the same size, though measurements could only be made on those smallest ones which fell most slowly; also droplets did not remain of constant size, smaller ones tending to evaporate and larger ones to grow; also there were unavoidable convection currents in the air which modified the rate of fall of the fog; and some droplets might contain more than one ion.

Millikan cleverly avoided or minimized these difficulties by using only a single droplet of some relatively non-volatile liquid like oil or mercury. By ionizing the surrounding air in an electric field he could put various electric charges on the drop. Illuminating it by a powerful light and viewing it like a star through a measuring telescope, he could measure its rate of fall under gravity and its rate of rise when pulled upward against gravity by an electric field, and keep repeating these observations for hours. These measurements were so precise that, to keep pace with them, he had to measure the viscosity of air with hitherto unequalled accuracy. When all this was done he had proved conclusively that all electric charges are integral multiples of a fundamental unit charge, the electron, whose value he set as $4.774(10)^{-10}$ electrostatic units, about 40 per cent. larger than the earlier estimates and believed by Millikan to be correct within one part in a thousand.

Within the past half dozen years, however, doubt has been thrown on the estimated accuracy of this value from quite a different direction, in work with x-rays. Originally x-ray diffraction experiments in crystals proved the geometric arrangement of atoms

in the crystals, but did not establish the scale of distances between atoms or the x-ray wave-length. These distances, once the arrangement of atoms was known, were calculated from absolute values of the weights of the atoms, which in turn were derived from electrochemical equivalents and the value of the electronic charge. Thus x-ray wave-lengths, masses of atoms and distances between atoms in crystals all had values dependent on knowledge of the charge of the electron.

Recently, however, A. H. Compton, Beardon and others have succeeded in making measurements of x-ray wave-lengths by diffracting x-rays from a grating ruled with 15,000 to 30,000 parallel fine lines to the inch, and operating near the angle of grazing incidence. These measurements involve only knowledge of the number of lines per inch on the grating, and the angles of incidence and diffraction of the x-rays—both depending only on measurements of length and capable of high precision. X-ray wave-lengths thus measured were a little different from the earlier accepted values, and this cast doubt on the accuracy of the electron charge value which had been used in the earlier x-ray estimates. The difference was not large, only one part in two hundred, but it meant either that experiments had not been as accurate as believed or that there was some unrecognized complicating factor.

So Millikan's work has been repeated in various laboratories with refinements, such as the use of a remarkably non-volatile oil for the drop. But the chief error was found to lie in the measurements of the viscosity of air. During the past year Kelletrop, of Uppsala, has thus published a revised "oil-drop" determination of electronic charge as $4.800(10)^{-10}$ e.s.u., which is in excellent agreement with the "x-ray" determinations. This morning Beardon has presented his own confirmation of this agreement before the American Physical Society.

It is an interesting coincidence that this best value of the electron's charge is exactly the same as the figure given by Rutherford thirty years ago, though then determined with so much less precision that not much confidence was placed in it, except as to order of magnitude. It was then known that the alpha rays from radium are helium atoms which have lost two electrons and are therefore doubly positively charged. Rutherford caught a lot of these alpha rays in a metal trap, measuring their aggregate electric charge with an electroscope, and counting them by the scintillations which they produced on striking a fluorescent screen or otherwise. Dividing the total charge by the number gave him double the electronic charge, which he thus calculated to be $4.8(10)^{-10}$ e.s.u.

Already knowing the ratio of charge to mass with high precision, this value of the charge enables us to fix the electron's mass as $9.051(10)^{-28}$ grams.

But when we speak of an electron's mass, we enter a whole new field of ideas. Some years before the discovery of electrons, J. J. Thomson had pointed out that an electrified particle will possess inertia, *i.e.*, mass, simply in virtue of its charge alone, irrespective of whether or not it has any mass of the gravitational type which we have been accustomed to think of. This "electromagnetic" mass comes about from the fact that any mechanical energy which is expended in accelerating an electric charge is transformed into the energy of the magnetic field which surrounds the electrified particle in virtue of its motion. In fact, the kinetic energy of a moving electric charge is found to be simply the energy of its magnetic field and depends only on the square of the velocity of the charge, the amount of charge and the geometrical shape of the charge.

Making the simplest possible assumptions about the shape of an electron, such as a solid sphere or a hollow spherical shell of electricity, and assuming all its mass to be of electromagnetic origin, the diameter of an electron was calculated to be of the order of $(10)^{-13}$ cm. It must be emphasized, however, that this estimate of size is not, like the charge and mass, a definite measurement, but is simply an estimate based on assumptions at least one of which is quite uncertain. For while we have both logic and experiment to back up the assumption that all the electron's mass is of this electromagnetic origin, we must confess to utter ignorance regarding the electron's shape. Indeed, some facts suggest that it may have different sizes and shapes in different environments, as in the free state or in an orbit of an atom or in the nucleus of an atom. So our estimate of $(10)^{-13}$ cm. for the size of an electron is, at best, very crude.

The idea of electromagnetic mass was strongly supported by the fact that measurements of the mass of very fast moving electrons, through measurements of the ratio of charge to mass of beta rays from radium or cathode rays in high voltage discharge tubes, showed that their mass is not really a constant thing but increases with the speed of the electron. The value of electron mass given above applies, strictly speaking, only to an electron at rest. Practically, however, it is accurate enough for practical purposes for electron speeds below about one tenth the speed of light. At this speed the electron's mass is about half of one per cent. larger than if it were at rest. At still higher speeds, the mass increases more and more rapidly, approaching infinite mass as the speed of light is approached.

These facts, experimentally determined, were shown by Abraham to be of the type expected if the entire mass of an electron is of electromagnetic origin, due entirely to its electric charge. It was this argument,

which has since received confirmation from other directions, which was the basis of the theory that all mass, *i.e.*, all matter, is electrical. However, the simple electromagnetic concepts were not quite adequate to give an accurate quantitative interpretation of these experiments, and it required the additional introduction by Lorentz of the concepts of the special theory of relativity to bring about complete interpretation of the experiments.

Just two things more do we know accurately about the properties of electrons, in addition to their charge and mass. We know that they are also tiny magnets of strength equal to the basic unit of magnetic moment generally called the Bohr magnetron. Once the electron had been discovered, it became natural to seek in it also the explanation of magnetic phenomena, since it was only necessary to assume that the electricity of an electron is whirling about an axis and the electron becomes endowed with the properties of a tiny magnet. Parsons, Webster and others examined the possibilities inherent in various assumed configurations, with interesting results. But it was only with the introduction of the quantum theory for the interpretation of atomic structure and spectra that the magnetic character of the electron has, within the last dozen years, been put on a well-established basis.

The other thing we know is perhaps the most unexpected of all the electron's properties—it behaves like a wave when it collides with other objects. Davisson and Germer discovered this in the Bell Laboratories, while examining the way in which a beam of electrons, incident on a solid surface, was scattered or reflected by it. They found, if the surface were crystalline, that the electrons were scattered just like diffracted x-rays, but that, unlike x-rays, the wave-length of an electron is not fixed but varies inversely as its speed. J. J. Thomson's son, G. P. Thomson, has made very illuminating studies of this phenomenon, which is the inverse of the Compton effect and which together have given physicists two mottoes: "Particles behave like waves and waves behave like particles" and "Here's to the electron: long may she wave." One of the triumphs of the new wave-mechanics (a brand of quantum mechanics) is that it offers a medium of explanation of these strange phenomena. But my subject of the electron is too long to let me attempt a digression on wave mechanics.

With this sketch of the electron itself before us, let us turn to some of the more important directions in which the electron has given us an interpretation of the physical universe generally. Immediately were explained the phenomena of electrolysis and of ionization generally, for ions were simply atoms or groups of atoms which had gained or lost one or more electrons. Primary chemical forces were explained as the electrostatic attraction between atomic groups which, respectively, contained an excess or a deficiency of electrons. (The more refined interpretation of chemical forces within the past half dozen years, by Pauling and Slater, has been based upon the quantum theory of atomic structure).

The three types of rays from radioactive substances were interpreted: alpha rays as helium atoms which had lost two electrons; beta rays as electrons, and gamma rays as x-ray-like radiations. In fact Becquerel showed the magnetic deflection of beta rays in the same year, 1897, that Thomson showed the magnetic deflection of cathode rays and interpreted them as electrons.

For many years two unexplained phenomena had been studied in metals. When highly heated or when illuminated by ultra-violet light, metals had been shown to emit negative electricity. It was the work of but a year, after the discovery of the electron, for J. J. Thomson and his pupils to show that both these phenomena consist in the emission of electrons. But by what mechanisms are they thus emitted? That was a question whose study has led to most important theoretical and practical consequences.

Richardson, first as a pupil of Thomson and then as a professor at Princeton in the early nineteen hundreds, developed the theory of thermionic emission of electrons, according to which the electrons are evaporated from the surface of a metal at high temperatures by a process very analogous to evaporation of molecules. The electrons are assumed to have the same distribution of kinetic energies that molecules possess at the same temperature in accordance with the principles of kinetic theory. They escape from the surface if they reach it with enough energy to take them away in spite of the attraction tending to pull the electron back into the metal. This attraction is expressed in terms of the now famous "work-function," a sort of latent heat of evaporation of electrons, which is the work that must be done to get an electron clear of the surface. With these simple assumptions, an equation was derived for the rate of emission of electricity as a function of temperature which has stood the test of perhaps as wide a range of experimentation as any other equation of physics, a range of values of more than a million-million fold in current without any detectable departure from the theory, if this is properly applied.

Richardson's measurements of the "work-functions" of various metals showed that these values run closely parallel with one of the longest known but least understood properties of metals—their contact potential properties. By contact difference of potential is meant the voltage difference between the surfaces of two metals when they are placed in contact. Richardson

found that the difference between the "work-functions" of two metals was, within the limits of accuracy of the data, the same as their contact difference of potential. He therefore proposed the theory that the contact potential property of a metal is determined simply by the work necessary to remove an electron from its surface.

As a beginning graduate student under Richardson in 1910 I was given the job of undertaking a test of this theory through experiments on the other electron-emitting phenomenon, the photoelectric effect. Einstein a few years before had proposed his famous photoelectric equation, which was a contribution to physical theory certainly comparable in importance and thus far more useful in its application than his more impressive and wider publicized general theory of relativity. According to it an electron in a metal may receive from the incident light an amount of energy proportional to the frequency of the light—to be exact, an energy equal to Planck's constant h times the frequency ν. If it escapes from the metal it must do an amount of work w to get away, so that its kinetic energy after escape from the metal would be the difference $h\nu - w$. Obviously, by measuring these kinetic energies of electrons liberated from various metals by light of various frequencies, it should be possible to find out if the "work-functions" w of different metals are indeed related to their contact differences of potential in the manner predicted by Richardson's theory.

In two papers, by me in 1911 and jointly with Richardson in 1912, it was concluded first that the contact differences of potential are related to the "work-functions" as Richardson had predicted, and second that Einstein's photoelectric equation, rather than a rival theory then under discussion, properly described the facts. Practically simultaneously with this second paper, there appeared the report of a similar verification of Einstein's equation by A. L. Hughes, then in England, though lacking the quantitative connection with contact differences of potential.

This early work was not very accurate, partly because of lack of good vacuum technique for maintaining untarnished surfaces in a vacuum, partly through lack of constant sources of ultra-violet light and partly because the ultra-violet spectrographs used to isolate the various wave-lengths of light gave a certain spectral impurity of scattered light of other wave-lengths. These sources of error were recognized but not overcome when Millikan, in 1916, made a striking advance by using doubly purified light or otherwise correcting for the effects of impurity, and secured a verification of Einstein's equation which was far more accurate than the earlier work as regards the value of Planck's constant h. In fact, Millikan's work remains to this day as one of the best determinations of this important constant. In regard to the "work-function," however, this work of Millikan's was not so successful, for, after having apparently discovered facts at variance with Richardson's interpretation of the equation and its relation to contact potentials, these differences were ultimately found to reside in faults of experimental procedure or interpretation, so that Richardson's interpretation of Einstein's equation still holds.

In both thermionic and photoelectric effects, theoretical refinements have been introduced by the recent quantum mechanics and great advances made in experimental technique. However, it is fair to say that their interpretations on the electron theory have been among the major achievements of this theory.

While we are on the subject of electricity in metals, what constitutes the phenomenon of easy flow of electricity that is the distinguishing feature of metals? J. J. Thomson at once suggested that this must be due to the existence in metals of electrons free from their parent atoms, moving freely, except for collisions, whenever an electric field was applied in the metal. The theory thus worked out was attractive, but it encountered inconsistencies. There was not even any real evidence that electricity in metals was conducted by electrons.

Then along came Tolman with one of his brilliant ideas, skilfully followed by experiment. It had earlier been suggested that, whatever are the carriers of electric current in metals, it should be possible to centrifuge them toward the periphery of a disk if this were rotated very rapidly about its axis. To be more specific, if electrons are free to move in metals and if a wire connects the center and the periphery of the rotating disk through lightly pressing brush contacts, electrons should be thrown out of the disk at its periphery and pass back into the center of the disk through the wire. It would be rather analogous to a current of water driven by a centrifugal pump through a pipe circuit. But all attempts to detect such currents proved futile, because the currents produced by the friction of the contact against the periphery were far larger than the currents to be expected from the centrifuging of electrons.

But Tolman devised two methods of giving powerful accelerations to metal conductors in such manner that he was able to measure the feeble electric currents that were produced as the carriers of electricity in the metal were shaken back and forth, and his calculations showed that these currents were indeed of the size to be expected if the current is carried by electrons. This is our direct evidence that electrons carry the electric current in metals. The mechanism by which they do this is now beginning to be disclosed by Slater, on the basis of an application of quantum mechanics and spectroscopic ideas to metals, and again is an example

of the refining power of the quantum theory to succeed where older classical theory was gropingly suggestive, but inadequate.

And now that I come to the most basic of all the phenomena which the electron has been called upon to interpret, I almost lose courage, for the subject is too vast and complex for anything but encyclopedic treatment. I refer to the structure of atoms. Previous to the discovery of the electron, literally nothing was known of the internal structure or composition of atoms. With this discovery, however, it immediately became evident that all atoms contain electrons and an equivalent amount of positive electricity in some form. It was again J. J. Thomson's genius which began the investigation of the inner atom. This was only about twenty-five years ago.

Thomson reasoned that if x-rays were made to fall on any substance the electrons in the atoms of the substance would be forced to vibrate back and forth by the powerful alternating electric forces in the x-ray waves. But, in thus vibrating back and forth, these electrons would reradiate secondary x-rays in all directions. He calculated just what fraction of the original x-ray energy ought to be thus reradiated by each electron and then set his pupils to measure just what this fraction was in specific cases. From the experimental results he was thus able to calculate the number of electrons which performed the reradiation in each case. These results indicated that the number of such acting electrons in each atom was about half the value of the chemical atomic weight of the atom. Thus first were counted the electrons in an atom.

Rutherford and his pupils, aided by the mathematical analysis of Darwin, tackled the problem from a different point of view. They studied the distribution of deflection of alpha particles, shot out of radioactive materials, as these alpha particles traversed thin sheets of solid materials. They found that this distribution was quantitatively what would be expected if the deflections were produced by ordinary electrostatic forces, varying inversely as the square of the distance, between the alpha particle and a very small object containing most of the mass in each atom. They were thus able to show that this small object was not more than one ten-thousandth of the diameter of the atom, that it contained substantially all the mass of the atom and that it carried a positive electric charge equal, in electronic units, to about half the chemical atomic weight of the atom.

Thus arose the concept that the atom is composed of a positive nucleus of small dimensions, surrounded by electrons to the number of about half the atomic weight.

This had scarcely become established when it was brilliantly refined and extended by Moseley, just before he went to his untimely death in the war in 1914. Moseley had made a most ingenious study of the spectra of x-rays of a large number of the chemical elements, using a modification of the x-ray spectroscopy technique developed by the Braggs. He found that the square roots of the frequencies of the characteristic x-ray lines were numerically very simply related to the number which gave the place of the element in the periodic table of the elements, so useful to chemists but so far entirely without explanation. Thus this number acquired a definite physical significance and is now well known as the "atomic number."

For all the elements heavier than hydrogen, this atomic number is about half the atomic weight and, to make a long story short, this atomic number turns out to be exactly the number of electronic units of charge on an atomic nucleus, or the number of electrons in the atom outside the nucleus. At the same time, Moseley's work proved to be one of the greatest advances ever made in the basic interpretive side of chemistry.

Now that the number of electrons in each atom was known, the next step was to wonder about how they were arranged, what held them in place and what they were doing in their spare time. Suggestions were not slow in coming. In fact, even before Moseley's work, two rival theories had appeared, one devised by chemist Lewis and extended by Langmuir to explain the directional symmetries of atoms as indicated by their molecular combining forms, and the other devised by physicist Bohr to account for spectra. Gradually the Bohr theory has been developed to include the symmetries of the Lewis-Langmuir theory, so that both may be said to be merged, with many major additions too numerous to mention.

It was Bohr's bold genius to cast off some of the fetters of classical mechanics, which had been pretty well proved inadequate to meet the situation, and to devise a new mechanics frankly to meet the simplest known facts of atomic structure and spectroscopy—the hydrogen atom and the atomic hydrogen spectrum. In doing so, he at one stroke brought into the same picture the quantum theory of radiation, the electronic structure of the atom and the facts of spectroscopy. He had his electron moving in a circular orbit around the nucleus under the regular laws of electrostatic attraction and centrifugal force. But he stipulated that only such orbits were possible in which the angular momentum of the electron was an integral multiple of Planck's constant h divided by 2π. And he stipulated that the electrons should not radiate energy while revolving in their orbits, but only when they jumped from one orbit to another. In this case the frequency of light radiated was equal to the change of energy of the electron between the two orbits, divided by Planck's constant h. With these assumptions, the spectra of

hydrogen and of ionized helium were quantitatively explained in their main features, but not in their finer details.

Then came the war, and we heard little of atomic structure in this country. But in Germany, Sommerfeld was extending Bohr's ideas in most interesting ways. He showed that, by considering elliptic as well as circular orbits and taking account of the variation of the electron's mass with speed, the fine details as well as the main features in the spectra of hydrogen and ionized helium were accurately explained. He also showed how the theory could be extended to deal with atoms where there were many electrons moving in orbits. He showed that these additional concepts were in the right direction to explain the more complicated spectra both in the visible and in the x-ray regions.

When this new work first was known in America, it started the most feverish and earnest scientific activity that the country has ever known and which is still in progress with undiminished zeal and with increasing productive effectiveness.

I well remember when the first copy of Sommerfeld's "Atombau und Spektrallinien" came to America in the possession of our friend, P. W. Bridgman. Until later copies arrived he knew no peace and enjoyed no privacy, for he was besieged by friends wanting to read the book, which he would not allow to go out of his possession. I recall too the sudden popularity of the only two or three men in this country who knew what a spectral series was. Heretofore practically our only interest in spectra had been in the culinary variety of spectroscopy used by chemists in identifying chemical elements. No interpretive quality to speak of had hitherto been attached to the peculiar numerical regularities which had been discovered in the vibration frequencies of groups of spectrum lines.

I recall, too, the dismay with which we found only a handful of mathematical physicists versed in the analytical dynamics underlying the new atomic structure theories. In the summer of 1921, having been taught by one of these few mathematical physicists, I went to the University of Michigan to lecture on Sommerfeld's theory, and found there also F. A. Saunders, invited to impart his knowledge of spectrum series. In the winter of 1926, Born and Jordan having just announced a new development in quantum mechanics, I found over twenty Americans in Göttingen at this fount of quantum wisdom. A year later they were at Zurich, with Schroedinger. A couple of years later Heisenberg at Leipzig and then Dirac at Cambridge held the Elijah mantle of quantum theory. In our own country contributions are coming rapidly, particularly in the fields of application to chemical interpretations, metals and other complex situations.

From all this has come the situation which permitted Dirac, a few years ago, to write: "The underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus completely known, and the difficulty is only that the exact application of these laws leads to equations much too complicated to be soluble." But if any ambitious young scientist be discouraged lest there be little left to do, let him consider the unexplored atomic nucleus or the fact that every attempt to apply these laws, which look so satisfactory to us now, discloses new realms of knowledge still unexplored.

Time forbids mention of the most interesting work which was done to check and extend the theories of atomic structure, through direct measurement of the energy states of atoms and molecules by carefully controlled bombardment of these molecules by electrons. Begun by Frank and Hertz in Germany, much of this work was done in America by Foote and Mohler at the Bureau of Standards, by my students at Princeton and by Tate's group at Minnesota, all since 1920. In fact, both the addresses in Section B to-morrow morning are on this subject, retiring vice-president Tate discussing "Electron Impacts in Gases" and President Richtmyer, of the Physical Society, speaking on "Multiple Ionization of Atoms."

Before leaving the interpretive triumphs of the electron, however, I can not refrain from jumping from the atom to the universe, to the interpretation of conditions on the stars. Spectra of stars had long been known, and these were interpreted as indicating that some stars consist principally of hydrogen, others of helium and others of many chemical elements like our sun. But in 1922 a young Indian physicist, Megh Nad Saha, first applied atomic structure theory and knowledge of ionizing potentials to the sun and stars. He considered ionization in the hot vapors of the stars to be like a chemical dissociation produced by heat, in which the products of dissociation are electrons and the positive ionic residues of the atoms, and in which the heats of dissociation are given by the ionizing potentials of the atoms. In this way was developed a rational quantitative interpretation of stellar spectra which has thrown enormous light on the problem of conditions of temperature, pressure and condition of the chemical elements in stars. Russell in America and Milne in England have ably applied and extended this theory.

And now, finally, I come to the last phase of my subject, the social significance of the electron. By this I mean, of course, its useful applications. The first of these was Edison's invention of a thermionic rectifier, based on his discovery that negative electricity would flow across a vacuum from a hot filament to an adjacent electrode, but would not flow in the opposite direction. This was some years before the electron

was discovered as the responsible agent in this phenomenon. But within a few years after the discovery of the electron, Fleming had shown that this same device will operate to rectify radio wave impulses, and thus permit their detection with a sensitive direct current instrument. From this was patented the Fleming valve.

Once the basic character of thermionic emission was understood, and spurred on by the opportunities opening up in the radio field, new inventions, improvements and applications of thermionic devices came rapidly. Of major importance was the three-electrode tube amplifier of De Forest. Industrial research laboratories in the communications and electric manufacturing business took the lead in developing techniques and in penetrating scientific exploration. Noteworthy were the vacuum techniques and the monomolecular layers of activating materials developed by Langmuir and the high-vacuum thermionic x-ray tube of Coolidge. In the Bell Laboratories, oxide-coated filament tubes of good performance were developed and applied particularly to use in long-distance telephony. Let me give just two illustrations of the marvelous powers of some of these instruments.

It has been calculated that the energy of a transatlantic radio signal caught by the receiving station in Newfoundland comes in at about the rate required to lift a fly seven inches in a year!

What is the largest number that has any physical significance? This is impossible to answer, being largely a matter of definition. But one common answer to this is $(10)^{110}$, or one followed by 110 ciphers. This is about the number of electrons (the smallest things known) which would be required to fill up the universe to the greatest distances discovered by astronomy, if the electrons could be imagined to be closely packed side by side to fill up this whole space. Yet this number, large as it is, is very small indeed compared with the aggregate factor by which the energy of a voice striking a telephone transmitter in San Francisco is amplified by electronic tubes in the process of a long distance telephone conversation to London. This amplification factor is about $(10)^{256}$, or unity followed by 256 ciphers. If the universe were multiplied in size by the number of times it is larger than an electron, it could still not hold as many electrons as the number of this telephone amplification factor!

Then, mostly within ten years or so, has come an active introduction of thermionic devices which are not highly evacuated, but operate with supplementary action of intense ionization of the gas in the tube. First of these were the low voltage arc rectifiers, like the Tungar. Most interesting and versatile are the thyratrons, which permit easy control of powerful currents and machinery, and which give a new means of converting alternating into direct current, or *vice versa*. In this group also are some of the new types of lamps, of high efficiency or special color.

Not so striking, but equally interesting have been the useful applications of the photoelectric effect. First was the use of sensitive photoelectric cells to replace the eye or photographic plate in astronomical telescopes. Then came sunshine meters, devices to open doors or count people or sort merchandise automatically or to register the speed and license number of the unwary autoist. Most important thus far are the current-producing mechanisms in the sound-movie apparatus and in television equipment.

While, commercially, radio, sound movies and long-distance telephony are at present of greatest importance, of no less importance, especially to us as scientists, are the marvelous tools which have been put into our hands for further research in practically every field of science, from physics and chemistry to psychology and criminology.

So we see how, within one generation, the electron has been discovered and examined, with its aid our intellectual outlook upon the universe has expanded in content and simplified in basic concept, and in its use mankind has the most versatile tool ever put to use. The end of the story is far from told. Every fact or relationship of the electron appears fuzzy with uncertainties when closely examined, for it can truly be said that every discovery discloses a dozen new problems. The field of practical and commercial uses of electronic devices is certainly still largely in its early stages of exploration.

This story illustrates in vivid manner a number of characteristics of scientific work, some of which I shall simply enumerate: (1) progress comes by spurts of advance as some big new idea opens up new territory, alternating with periods of consolidation; (2) progress comes not by revolution or discarding of past knowledge and experience, but is built upon past experience and is its natural extension once the vision from new vantage points is secured; (3) there is nothing so practical in its values as accurate knowledge, and the pursuit of such knowledge has been most successful when not fettered with the initial demand that it be directed toward practical ends.

I would not give you the impression that it is only the electron which has given new life to modern physical science. A story of similar interest could be built around the new concepts of radiation and atomic energy as expressed in the quantum theory, or about the electron's big brother, the proton, or his rather nondescript cousin, the neutron. In the atomic nucleus is a field of further exploration of enormous promise, now only beginning to be opened up by use

of radioactive materials, cyclatrons and high-voltage generators.

Although these things have happened very recently, no one has better described the process and intellectual value of this type of scientific research than did Aristotle in the quotation which is inscribed in Greek on the façade of the National Academy of Sciences Building in Washington: "The search for truth is in one way hard and in another easy, for it is evident that no one can master it fully nor miss it wholly. But each adds a little to our knowledge of Nature, and from all the facts assembled there arises a certain grandeur."

OBITUARY

THEODORE JAMES BRADLEY

ON Friday, December 11, American pharmacy was made immeasurably poorer by the death of Dr. Theodore James Bradley, dean of the Massachusetts College of Pharmacy and president of the American Association of Colleges of Pharmacy. Dean Bradley was born in Albany, New York, sixty-two years ago last August.

He was graduated from the Albany College of Pharmacy in 1895 and taught in this institution for seventeen years following graduation. He was professor of mathematics in the Albany Academy for sixteen years and taught chemistry at the Albany Medical College from 1897–1907, inclusive. In 1912 he became dean of the Massachusetts College of Pharmacy, where he would have completed his 25th year of service in June, 1937.

Under Dean Bradley's administration, the Massachusetts College of Pharmacy has enjoyed a most unusual development and growth. It is housed in one of the finest pharmacy college buildings in the United States, is well equipped and enjoys a very substantial endowment.

Dean Bradley was a member of the U. S. Pharmacopoeia X and XI Revision Committees. He acted as secretary-treasurer of the American Association of Colleges of Pharmacy from 1917 to 1922. He was a member of the American Pharmaceutical Association for forty years, an association which he served as president in 1926. In August, 1936, he was elected president of the American Association of Colleges of Pharmacy, an organization which he served long and faithfully for many years. He was a member of the American Chemical Society and various other professional and scientific organizations.

He was given the honorary master of arts degree by Union University in 1912. In 1927 the Massachusetts College of Pharmacy conferred upon him the honorary degree of doctor of pharmacy and in 1927 the Philadelphia College of Pharmacy and Science granted him the degree of master of pharmacy.

Dean Bradley was the author of two text-books which are widely used in colleges of pharmacy in this country. He has written many articles for the pharmaceutical press and has made almost innumerable addresses at national and state conventions of various pharmaceutical bodies.

Dean Bradley is survived by his widow and three children, to whom we extend heartfelt sympathy.

Dean Bradley was one of the most respected men in American pharmacy to-day. He was admired for his fundamental honesty and profound loyalty to his friends and the various worthy enterprises for which he worked during his lifetime. Pharmacy has been greatly enriched by his splendid life of sacrifice and service. His death will be deeply felt and mourned by his great host of friends in various parts of the country.

E. L.

GEORGE C. CROWE

GEORGE C. CROWE, assistant park naturalist of Yellowstone National Park, died in the Park Hospital in Livingston on October 27, after a week's illness. His body was taken to Oakland, California, for burial. Mr. Crowe, who was 47 years old, was first taken ill on October 21 and rushed to the Park Hospital. He is survived by his widow and three children—Helen, 9; Margaret, 17; Robert, 20—his mother and two sisters.

He had served the National Park Service since 1929, as junior naturalist at Yosemite National Park, custodian at Devils Tower National Monument and as junior and assistant park naturalist at Yellowstone since March, 1932. His student days were spent at the University of California, majoring in mining and geology.

On leaving college, he toured the United States lecturing on the contemplated Panama-Pacific Exposition in San Francisco. Then followed several years of service with the Boy Scouts of America. After demonstrating his ability as a nature guide in Yosemite, he joined the naturalist staff.

His enthusiasm for his work was unbounded, and his endeavor to be of service to the park visitor was conspicuous. As a result he led thousands to an intimate knowledge of the scientific features of the national parks and made countless friends for park ideals and standards. Around the evening campfire, he exhibited great ability as a leader and entertainer, but never forgot the importance of the educational opportunities which such gatherings possess. Every museum enterprise with which he was connected showed the result

of artistic ability at graphic presentation, and many were the interesting observations he recorded in park *Nature Notes*.

Mr. Crowe, with an all-round knowledge of nature and her laws and ability to arouse enthusiasm for nature study in park visitors, exemplified the highest ideals of the naturalist service, which endeavors to bring to every visitor to the national parks a maximum of knowledge and appreciation of its chief features.

George C. Crowe was known to hundreds of high-school and college students in Montana and Wyoming through his lectures on park wildlife, and he had interested himself in the past four years in the CCC enrollees in Yellowstone National Park. Acting Superintendent J. W. Emmert paid tribute to him as an "extremely faithful, conscientious, and capable employee," and the Livingston *Enterprise* said, in an editorial, "The shock brought by news of Naturalist Crowe's death caused wide grief and sadness. The National Park Service and the communities of Mammoth and Livingston can ill afford to lose such sterling character as he possessed."

H. C. BRYANT

RECENT DEATHS

DR. HENRY S. PLUMMER, professor of medicine in the Graduate Medical School of the University of Minnesota, chief of the division of medicine of the Mayo Clinic and president of the Mayo Foundation, died on January 1 at the age of sixty-two years.

PROFESSOR CHARLES WINTHROP CROCKETT, who retired two years ago as head of the department of astronomy and mathematics at the Rensselaer Polytechnic Institute, died on December 30 at the age of seventy-four years.

DR. PHILIP EMBURY BROWNING, who retired as associate professor of chemistry at Yale University in 1932, died on January 2 at the age of seventy years.

DR. THEODORE JAMES BRADLEY, since 1912 professor of chemistry and dean of the Massachusetts College of Pharmacy, died on December 11. He was sixty-two years old.

THE death at the age of sixty-five years is announced of Sir Grafton Elliot Smith, professor of anatomy in the University of London.

SIR JOHN ROBERTSON, professor of public health in the University of Birmingham, died on December 16 in his seventy-fifth year.

DR. CARL STUMPF, professor of psychology at the University of Berlin, died on December 29 at the age of eighty-eight years.

SCIENTIFIC EVENTS

THE INTERNATIONAL CONGRESS OF GENETICS

THE translation given below of an article appearing in *Isvestia*, Moscow, on December 21, 1936, has been sent to SCIENCE by the Tass Telegraph Agency of the USSR, with a request for its publication.

In connection with the postponement of the convocation of the International Genetics Congress, an American agency, *Science Service*, comes forward with a statement about the "non-existence of intellectual freedom" in the USSR, and the *New York Times* has a report of the arrests of Professors Agol and Vavilov in the USSR. We have the following to report:

First. There really does not exist in the USSR that "freedom" of genetic science which in certain states is understood as freedom to kill people or as freedom to destroy whole nations because of their alleged "inferiority."

Second. Real freedom of research, real intellectual freedom exists only in the USSR, where science works not for the benefit and the hire of a narrow group of capitalists but for the good of, and in the interest of, all peoples and of the whole of mankind. Evidence of this is shown by the public discussion on problems of genetics which is now proceeding in the sessions of the Lenin Agricultural Academy with the participation of over five hundred scientists. The allegedly arrested Professor Vavilov, as has already been announced in the Soviet press, on December 22, will deliver a report at a session of the academy criticizing the scientific views of the young scientist, Lysenko, while the latter will read a paper criticizing the anti-Darwinist character of certain of Professor Vavilov's theoretical positions. Regarding the alleged arrest of Professor Vavilov, the *New York Times* simply lied.

Third. Mr. Agol, who has nothing in common with science, has been arrested by the organs of investigation for direct connection with the Trotzkyite murderers. With such gentlemen the USSR will invariably deal similarly in the future, no matter with what sort of supposedly scientific protective flag they might attempt to hide their criminal activity against the state. There really does not exist in the USSR "freedom" for murderers or "freedom" for propaganda of terrorism.

Fourth. The Genetic Congress, previously scheduled for 1937, has been postponed for a certain time upon the request of a number of scientists who desired more time for their preparations for the congress. The only purpose of this postponement is the desire to assure the best preparation and the most extensive participation of scientists from various countries.

THE U. S. BIOLOGICAL SURVEY

IN his annual report to the Secretary of Agriculture, Dr. Ira N. Gabrielson, chief of the Biological Survey, points out that the success of rebuilding wildlife

depends on close cooperation of landowners and conservation agencies.

Practical plans that will provide for wildlife needs without interfering with other desirable objectives are being furnished by the survey to federal, state and local agencies that administer land. The survey also has put into operation this year nine cooperative wildlife research and demonstration units at land-grant colleges to show landowners that it is not only desirable but also practical to consider wildlife in their land use programs.

The principal research activities during the past year included the following: Intensified investigation of waterfowl conditions and habitats; transplanting of Pacific-coast eelgrass at certain points along the Atlantic coast in an experiment to reestablish an important waterfowl food all but eradicated by disease; renewed efforts to insure preservation of wildlife habitat in areas where mosquito-control work is planned or in progress; studies of the effects of crow-waterfowl relationships on breeding grounds and efforts to determine the effects of crow control on duckling mortality, and investigation of fox depredations on quail through a study of mortality at nests and studies of the local food habits of foxes. The bureau developed a self-feeding system at the Rabbit Experiment Station in California that reduces feed costs with production of superior-quality meat and established a research center at the Wichita Mountains Wildlife Refuge in Oklahoma. Congress authorized the purchase of land in New York on which the Fur Animal Experiment Station is located.

Biologists of the survey also continued research on forest wildlife relationships and investigations of Alaskan conditions for buffalo and musk oxen. Important bird colonies not heretofore mentioned in reports or literature were discovered on some of the major islands of the Aleutian chain by a field party, including two biologists, that spent five months in studying conditions of wildlife on these islands.

The report says that more than 225,000 birds were banded by cooperators of the bureau during the year; 269 mammal specimens were added to the collection, and 305 bird specimens were acquired.

Other features of the year's work summarized by Dr. Gabrielson in the early pages of his report are as follows:

Thirty-two small refuges were established in North Dakota on areas reserved for wildlife and water conservation by means of gratuitous easements. An allotment of $286,240 from the Works Progress Administration made it possible to develop the refuges.

An act to make effective in this country a convention between the United States and Mexico for the protection of migratory birds and game animals was passed by the Congress and approved by President Roosevelt. Two investigators cooperated with Mexican authorities in the preliminary work on the treaty. Mexico has not yet ratified. The convention will become effective upon exchange of ratifications.

By a cooperative arrangement with the Works Progress Administration the bureau will investigate all proposed drainage projects that may materially affect wildlife environment.

The number of injurious rodents was reduced on 32,547,769 acres for the protection of farm crops, range grasses, silvicultural plantings, reclamation waterways and surface soils threatened by erosion. Rodent control was extended to Hawaii, where rats seriously interfere with pineapple and sugarcane production and menace public health as carriers of bubonic plague.

GIFT OF THE GENERAL EDUCATION BOARD TO THE MEDICAL SCHOOL OF THE UNIVERSITY OF CHICAGO

THE General Education Board of New York has given to the University of Chicago the sum of $3,000,000 to be spent for the development of the Medical School and the improvement of the university generally. This is the largest unrestricted gift ever received by the university.

President Robert M. Hutchins stated that the money presumably will be expended during the next five or six years and emphasized the necessity of undertaking within that period to replace the gift by raising additional endowment of not less than $15,000,000 for medical and general university support.

Although the trustees have absolute discretion in spending the grant, the background of the discussions leading to the gift suggested that about $360,000 a year would go to medicine. Dr. Hutchins explained that the primary interest of the General Education Board in making the grant was in medicine. The Medical School was founded in 1927 with the help of the board, which since has been making temporary grants to assist the school. The present gift is intended to continue these grants and to provide a substantial sum for improvement.

The board regarded support of the university generally as incidental to the support of the Medical School, believing it impossible to develop a strong medical school apart from a strong university because of the dependence of medical education and research on the closest possible association with good departments in the natural sciences.

In making this grant, the board made clear the fact that the gift was not to be regarded as implying the existence of any peculiar responsibility to the University of Chicago.

The following statement was made:

We do not recognize any such responsibility, nor have our trustees ever considered that they were under any

obligation to the university that differed in any way from the obligation which they have to other institutions of similar rank.

We emphasize this point because in some quarters it has been intimated that public opinion in the Middle West and elsewhere has believed that the Rockefeller board bore a peculiar and unique relationship to the university which was not shared by other educational institutions. For the sake of the university itself, and the necessity which it faces of developing a broad basis of financial support, we would want emphatically to disavow this opinion.

Of the $360,000 a year to be devoted to medicine, $250,000 continues present grants and $110,000 probably will be used to support free beds in the university hospitals. This sum would support 46 free beds, and contribute to the educational and scientific effectiveness of the faculty of the school. The money made available for general purposes of the university probably will be used for new appointments, research, library books and salary increases.

AWARD OF THE EDISON MEDAL TO DR. ALEX DOW

DR. ALEX DOW, president of the Detroit Edison Company, has been awarded the Edison Medal for 1936 of the American Institute of Electrical Engineers "for outstanding leadership in the development of the central station industry and its service to the public." The medal, which was founded by friends and associates of the late Thomas A. Edison and is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts," will be presented to Dr. Dow during the winter convention of the institute in New York City, which will be held from January 25 to 29.

Dr. Dow was born in Glasgow, Scotland, in 1862, and although he is not a graduate of a technical school, he has received the honorary degrees of master of engineering (1911) and doctor of engineering (1924) from the University of Michigan and doctor of science (1935) from the University of Detroit.

During the period 1874–82, he was employed as junior clerk and stenographer in a railroad office and in the offices of a steamship company in Liverpool, England. In 1882 he came to the United States, and was employed in various departments of the Baltimore and Ohio Railroad Company. Later he was transferred to the Baltimore and Ohio Telegraph Company to take charge of local line and instrument maintenance, with some construction and experimental work on telephones. In 1888 he was employed by the Brush Electric Company, Cleveland, Ohio, as installation electrician in the Chicago office, becoming district engineer in that office in 1889. In 1893, he accepted the opportunity to design and supervise the construction of the original public lighting plant of the city of Detroit, and in 1896 he became vice-president and general manager of the Edison Illuminating Company of Detroit. This company was succeeded by the Detroit Edison Company in 1903, and Dr. Dow was retained as vice-president until 1913, when he was made president.

Dr. Dow became a naturalized citizen in 1895. He has been a leading pioneer in the United States in the engineering, rate making and general operation of the electric light and power utility, and is given credit for both the engineering and financial success of his enterprises. He has supervised the design and construction of several generating stations of the Detroit Edison system and he is called the father of the so-called "big" steam boiler in the United States, having installed 2,350-horsepower boilers at a time when 600- to 750-horsepower units were commonly considered large. He was the first to adopt the underfeed stoker for large installations, and much of the earlier development of this type of equipment was made in his power plants.

OFFICERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

OFFICERS elected at the meeting of the council of the American Association on December 31 are as follows:

President: George D. Birkhoff, Harvard University.

Permanent Secretary: Forest R. Moulton, Chicago.

General Secretary: Otis W. Caldwell, Boyce Thompson Institute for Plant Research.

Treasurer: John L. Wirt, Washington.

Members of the Executive Committee: Edwin G. Conklin, Princeton University; Henry B. Ward, University of Illinois (emeritus).

Members of the Council: Vincent du Vigneaud, George Washington University; Sam F. Trelease, Columbia University.

Members of the Finance Committee: Arthur Keith, U. S. Geological Survey; Charles S. Baker, Washington.

Members of the Grants Committee: A. T. Poffenberger (Psychology), Columbia University; Jacob G. Lipman (Agriculture), New Jersey Agricultural Experiment Station.

Trustee on the Board of Science Service: J. McKeen Cattell, editor of SCIENCE.

Vice-presidents of the Association and Chairmen of the Sections:

Mathematics (A): W. D. Cairns, Oberlin College.

Physics (B): Harvey Fletcher, Bell Telephone Laboratories.

Chemistry (C): Farrington Daniels, University of Wisconsin.

Astronomy (D): Philip Fox, Adler Planetarium and Astronomical Museum.
Geology and Geography (E): Kirtley F. Mather, Harvard University.
Zoological Sciences (F): Ralph S. Lillie, University of Chicago.
Botanical Sciences (G): F. E. Denny, Boyce Thompson Institute.
Anthropology (H): John R. Swanton, U. S. Bureau of American Ethnology.
Psychology (I): A. T. Poffenberger, Columbia University.
Social and Economic Sciences (K): Stuart Rice, U. S. Bureau of the Census.
Historical and Philological Sciences (L): R. C. Archibald, Brown University.
Engineering (M): J. W. Barker, Columbia University.
Medical Sciences (N): Esmond R. Long, University of Pennsylvania.
Agriculture (O): E. C. Auchter, U. S. Bureau of Plant Industry.
Education (Q): Ralph Tyler, the Ohio State University.

Secretaries of Sections:
Mathematics (A): E. R. Hedrick, University of California at Los Angeles.
Physics (B): H. A. Barton, American Institute of Physics.
Chemistry (C): Neil E. Gordon, Central College, Fayette, Mo.
Astronomy (D): Harlan T. Stetson, Massachusetts Institute of Technology.
Geology and Geography (E): Howard Meyerhoff, Smith College.
Zoological Sciences (F): George A. Baitsell, Yale University.
Botanical Sciences (G): J. T. Buchholz, University of Illinois.
Anthropology (H): W. M. Krogman, Western Reserve University.
Psychology (I): Leonard Carmichael, University of Rochester.
Social and Economic Sciences (K): E. P. Hutchinson.
Historical and Philological Sciences (L): Joseph Mayer, Library of Congress.
Engineering (M): F. M. Feiker.
Medical Sciences (N): Malcolm Soule, University of Michigan.
Agriculture (O): M. F. Morgan, Connecticut Agricultural Experiment Station.
Education (Q): P. M. Symonds, Teachers College, Columbia University.

Members of the Sectional Committees:
Mathematics (A): M. H. Stone, Harvard University.
Physics (B): J. W. Beams, University of Virginia.
Chemistry (C): Irving Langmuir, General Electric Company.
Astronomy (D): Carl O. Lampland, Lowell Observatory.
Geology and Geography (E): Preston E. James, University of Michigan.
Zoological Sciences (F): J. H. Bodine, University of Iowa.
Botanical Sciences (G): Neil E. Stevens, U. S. Bureau of Plant Industry.
Anthropology (H): Carl Guthe, University of Michigan.
Psychology (I): E. C. Tolman, University of California.
Social and Economic Sciences (K): H. G. Moulton, Brookings Institution.
Historical and Philological Sciences (L): Max Farrand, Huntington Library.
Engineering (M): F. L. Bishop, University of Pittsburgh.
Medical Sciences (N): Paul R. Cannon, University of Chicago.
Agriculture (O): R. J. Garber, West Virginia University.
Education (Q): E. J. Ashbaugh, Miami University.

SCIENTIFIC NOTES AND NEWS

AT the meeting of the American Association for the Advancement of Science held last week at Atlantic City, Dr. George D. Birkhoff, Perkins professor of mathematics and dean of the Faculty of Arts and Sciences at Harvard University, was elected president, to succeed Dr. Edwin G. Conklin, professor emeritus of zoology at Princeton University. Dr. Forest R. Moulton, formerly professor of astronomy at the University of Chicago, was elected permanent secretary to succeed Dr. Henry B. Ward, emeritus professor of zoology in the University of Illinois. Other officers elected are given in a note under "Scientific Events." A full account of the meeting, prepared by the permanent secretary with the cooperation of the secretaries of the sections and affiliated societies, will be printed in the issue of SCIENCE for February 5.

THE annual prize of $1,000 of the American Association for the Advancement of Science for a paper containing "an outstanding contribution to science presented at the meeting" was awarded at the Atlantic City meeting to Dr. Wendell M. Stanley, of the Rockefeller Institute for Medical Research, Princeton, N. J., for his paper entitled "Chemical Studies on the Virus of Tobacco Mosaic Disease."

DR. EDMUND W. SINNOTT, professor of botany at Barnard College, Columbia University, was elected at the Atlantic City meeting president of the Botanical Society of America. He succeeds Dr. C. Stuart Gager, director of the Brooklyn Botanic Garden.

DR. CHARLES PALACHE, professor of mineralogy at Harvard University, has been elected president of the

Geological Society of America at the Cincinnati meeting. He succeeds Dr. W. C. Mendenhall, director of the U. S. Geological Survey. The vice-presidents elected are: Dr. W. O. Hotchkiss, president of the Rensselaer Polytechnic Institute, Troy, N. Y.; Dr. G. D. Harris, of Cornell University, Ithaca, N. Y.; Professor Charles P. Berkey, of Columbia University, and Professor C. R. Longwell, of Yale University.

THE Paleontological Society of America, meeting in Cincinnati on December 29, elected Dr. Joseph A. Cushman, of Sharon, Mass., to the presidency. Dr. Carey G. Croneis, of the University of Chicago, was elected vice-president, and Dr. B. F. Howell, of Princeton University, Dr. Carl C. Dunbar, of Yale University, and Dr. John B. Reeside, of the U. S. Geological Survey, were reelected secretary, treasurer and editor, respectively.

DR. NORMAN L. BOWEN, of the Geophysical Laboratory of the Carnegie Institution of Washington, was elected president of the Mineralogical Society of America, which met in Cincinnati in conjunction with the American Geological Society. Dr. Bowen succeeds Professor William S. Bayley, of the University of Illinois.

DR. WILDER PENFIELD, director of the Montreal Neurological Institute, was elected president of the Association for Research in Nervous and Mental Disease at the closing session of the New York meeting. He succeeds Dr. Walter Timme, of Columbia University. Dr. Angus M. Frantz and Dr. Clarence Hare, both of New York City, were elected secretary-treasurer and assistant secretary, respectively.

IN honor of Dr. William Albert Setchell, professor of botany at the University of California since 1895, a book of "Essays in Geobotany" written by a group of his professional associates from many parts of the world and edited by Dr. T. H. Goodspeed, of the university, has been compiled. The book includes articles by O. W. Arrhenius, E. B. Babcock, F. E. Clements, W. S. Cooper, Ludwig Diels, F. E. Fritsch, D. R. Hoagland, E. D. Merrill, Eduard Rübel and Carl Skottsberg.

AT the celebration of the eightieth birthday on December 31 of Brigadier-General David L. Brainard, U.S.A., retired, of Washington, the last survivor of Lady Franklin Bay Arctic expedition of 1881–1884, commanded by General A. W. Greely, the American Polar Society, of which General Brainard is the oldest active member, elected him its first honorary member "in recognition of his contribution to Polar exploration." He was presented with a scroll on which is inscribed a map showing the route taken by Lieutenant James B. Lockwood and himself, then a sergeant, which enabled them on May 13, 1882, to reach the then highest point north, latitude 83 degrees, 24 minutes, 30 seconds, on the northern coast of Greenland.

AT the fiftieth anniversary celebration of the founding of Newcomb College of Tulane University, the degree of doctor of science was conferred on Dr. Alice Hamilton, formerly assistant professor of industrial medicine at the Harvard University School of Medicine, now consultant for the Division of Labor Standards in the U. S. Department of Labor. Preceding the conferring of the degree Dr. Hamilton gave an address on "Industrial Poisons." Later a reception was held in her honor.

AT the annual dinner of the American Society of Animal Production given recently in Chicago, a portrait of Dr. W. C. Coffey, dean and head of the department of agriculture of the University of Minnesota, was presented to the Saddle and Sirloin Club. It will be hung in the Hall of Fame of the club. Dean Coffey was cited for his work in animal husbandry and was the guest of honor at the dinner. President L. D. Coffman was the principal speaker, and Dr. Andrew Boss, formerly vice-director of the Minnesota Agricultural Experiment Station, spoke of Dean Coffey's work at the University of Minnesota.

AFTER twenty years of active service at the University of Maryland, Professor Charles J. Pierson has retired as chairman of the department of zoology. He will continue to teach the courses in vertebrate morphology. Dr. Norman E. Phillips, associate professor of zoology, succeeds him as chairman of the department.

IN the department of pediatrics of the Long Island College of Medicine, Dr. Charles A. Weymuller has been promoted to a professorship; Dr. Lambert Krahulik has been appointed professor of clinical pediatrics; Dr. Stanley S. Lamm, Dr. Lewis A. Koch and Dr. David H. Shelling have been appointed assistant clinical professors. A professorship of child health and welfare, in the Division of Preventive Medicine and Community Health, has been established, and Dr. Carl H. Laws has been chosen as the first incumbent of this chair.

DR. L. J. NORTON, of the University of Illinois, has resumed his work as professor of agricultural economics after eighteen months' leave in order that he might serve as vice-president of the Production Credit Corporation of St. Louis.

DR. KARL MENGER, professor of mathematics at the University of Vienna, will join the permanent staff of the department of mathematics at the University of Notre Dame at the opening of the second semester.

DR. H. S. RUSE, lecturer at the University of Edinburgh, has been appointed professor of mathematics at University College, Southampton, to succeed the late Professor R. C. J. Howland.

THE title of emeritus professor of the University of London has been conferred on members of the faculty who retired at the close of the academic year as follows: Sir Grafton Elliot Smith, professor of anatomy at University College, whose death has since been announced; M. T. M. Ormsby, Chadwick professor of municipal engineering at University College; A. E. Jolliffe, professor of mathematics at King's College; Dr. W. A. Bone, professor of chemical technology at the Imperial College of Science and Technology; Dr. Alfred Fowler, professor of astrophysics at the Imperial College of Science and Technology; Dr. E. W. Macbride, professor of zoology at the Imperial College of Science and Technology; Dr. S. J. Truscott, professor of mining at the Imperial College of Science and Technology; Dr. W. W. Watts, professor of geology at the Imperial College of Science and Technology.

DR. EDWARD A. BIRGE, president emeritus of the University of Wisconsin, has been elected curator of the Wisconsin State Historical Society.

PAUL H. ALLEN has been appointed resident manager of the tropical station of the Missouri Botanical Garden at Balboa, Panama. He plans to conduct a scientific survey of plant life and to make collections.

THE new laboratory for sub-tropical and tropical diseases at Bellevue Hospital, New York City, will be under the immediate supervision of Dr. Douglas Symmers, general director of laboratories of the Department of Hospitals, and will be in charge of Dr. Harry Most, of the New York University Medical College, and of Dr. Amanda Hoff, of Columbia University, both graduates of the London School of Tropical Medicine.

DR. CARL J. WIGGERS, professor of physiology at the School of Medicine of Western Reserve University, has been granted leave of absence. He plans to make a trip around the world to visit medical schools at Cairo, Beirut, Bombay, Bangkok, Nanking, Peiping, Kyoto and Tokyo. He will sail with Mrs. Wiggers on January 23.

ACCORDING to press dispatches from Moscow, the All-Union Academy of Science has expelled two members on charges of violating the constitution by refusing to return to continue their scientific work in Russia. They are Dr. Vladimir N. Ipatyeff, director of chemical research in the laboratory of the Universal Oil Company, Chicago, and Professor Alexis E. Chichibabin, now working in a private laboratory in Paris.

DR. EDWIN P. HUBBLE, astronomer of the Mount Wilson Observatory of the Carnegie Institution of Washington, who during the past year has been Rhodes memorial lecturer at the University of Oxford, gave an illustrated lecture at the institution on January 5. He spoke on "Our Sample of the Universe."

EDWARD C. MOLINA, of the Bell Telephone Laboratories, gave an address on November 30 at the Iowa State College on "Probability in Engineering." In the evening Mr. Molina was a guest of Sigma Xi, before which he gave an address on "A Tour through the Probability Domain."

THE fourth annual lecture in the E. Starr Judd lectureship in surgery, established at the University of Minnesota by the late Dr. E. Starr Judd, will be given on February 3 by Dr. Evarts A. Graham, professor of surgery at the Washington University School of Medicine and surgeon-in-chief of the Barnes and St. Louis Children's Hospitals at St. Louis. The subject of the lecture will be "Accomplishments of Thoracic Surgery and its Present Problems."

A. I. LEVORSEN, consulting geologist of Tulsa, Okla., president of the American Association of Petroleum Geologists, 1935–36, gave during December a series of lectures under the auspices of the department of geology at the University of Kansas.

DR. MAUD SLYE, of the University of Chicago, lectured on October 5 on the results of her work on the rôle of heredity in cancer at the medical school of the University of Paris.

A LIMITED number of post-doctorate fellowships in physics (including astronomy), chemistry and mathematics will be available through the National Research Council for the academic year 1937–38. These fellowships carry stipends from $1,600 upward with certain allowances for dependents and are open to citizens (men and women) of the United States and Canada under the age of thirty-five years, for study in the United States or, under special conditions, abroad. Application for appointment to these fellowships should be filed with the secretary of the Fellowship Board in Physics, Chemistry and Mathematics, National Research Council, 2101 Constitution Avenue, Washington, D. C., before March 1.

THE late William C. Endicott, who died on November 28, provided in his will for bequests of $100,000 each to the Hunt Memorial Hospital, Danvers, Mass., and the Massachusetts Historical Society.

A GIFT of £200,000, twice as large as any single gift received during its history, has been made to the University of Leeds by Frank Parkinson, a former student. The gift is to be used for the proposed main

frontage to the university in connection with the reconstruction scheme which has been proceeding for some years. Last June Mr. Parkinson gave to the university £50,000 for the establishment of a scholarship fund which is now in operation.

A DONATION of £10,000 has been made by the Imperial Chemical Industries, Ltd., towards the erection of a new building for chemistry at the University of Glasgow.

Museum News reports that the National Zoological Park, Washington, D. C., recently opened the new wing to the bird house. The new structure, costing $100,000, is the first of the buildings to be opened under the $880,000 PWA construction program, which includes a new elephant house, a new house for apes and small mammals, and various service buildings. In the new bird wing the cages have glass fronts instead of the usual wire, and skylights which can be thrown back in fair weather to give the birds direct sunshine. Two large panorama cages occupy opposite ends of the house, one refrigerated for Arctic birds, the other for tropical birds. There is a tank for diving birds. The new wing opens into two corridors from the old bird house.

THE faculty of Rush Medical College of the University of Chicago recently voted to abolish the requirement of the fifth year for the degree of doctor of medicine, effective on December 15. Certain additional provisions were made for students who have received the four-year certificate since 1934 and who never received their degree because of illness and for students who received the certificate in the past year who were either not under contract to a hospital or whose contract could be altered by the hospital concerned to permit them to receive their degree before completing their internships.

THE Academy of Natural Sciences of Philadelphia has published the first issue of a popular magazine entitled *Frontiers*. Effingham B. Morris, president of the academy, in an introductory note states that the magazine "is addressed to all persons, old or young, who wish to increase their knowledge of the world of nature." It will appear five times a year—in October, November, January, March and May. It will be sent without extra charge to members of the academy and will also be offered for sale generally. Members of the advisory editorial committee are Cary Bok, trustee of the academy; Robert K. Enders, assistant professor of zoology at Swarthmore College; John M. Fogg, Jr., assistant professor of botany at the University of Pennsylvania; Witmer Stone, vice-president of the academy, and John H. Fulweiler, secretary.

THE *Journal* of the American Medical Association states that the association and the National Broadcasting Company are presenting the second series of dramatized health broadcasts under the title "Your Health." The first broadcast in the new series, the thirty-second dramatized cooperative broadcast under the title "Your Health," was given on October 13. The theme for 1936–1937 differs slightly from the topic in the first series, which was "medical emergencies and how they are met." The new series is built around the central idea that "100,000 American physicians in great cities and tiny villages, who are members of the American Medical Association and of county and state medical societies, stand ready, day and night, to serve American people in sickness and in health."

DISCUSSION

THE INTERRELATIONSHIP OF VITAMIN A AND GLUCURONIC ACID IN MUCINE METABOLISM

A DEFICIENCY of vitamin A is known to produce metaplastic changes in the mucous epithelium. Clinically the advent of metaplasia is noted by the presence of xerosis. As the deficiency becomes more pronounced, xerosis is followed by keratinization, and this in turn by desquamation. Washings from the conjunctival sac and urinary sediment show an increase in the number of desquamated epithelial cells, thus providing evidence that these structures are suffering from a shortage of vitamin A.

The mucosa of the gastro-intestinal tract does not provide evidence of this sort so readily. This tract is, however, exposed to more traumatic injury than any other system having a lining of mucous epithelium. We have shown by actual goblet cell counts of comparable areas of entire villi that there is a marked reduction in the number of mucus-secreting elements and an increase in the number of goblet cells showing reduced activity in vitamin A deficiency. A reduction in the amount of mucus exposes the lining of the stomach, pylorus and large intestine, especially, to injuries produced by the solid components of the food or feces. These will result in capillary bleeding, which in turn will be responsible for blood in the stools. We believe that the occurrence of occult blood in the feces is the earliest evidence obtainable of a deficiency of vitamin A.

A prosthetic portion of the mucin molecule is glycuronic acid. In vitamin A deficiency, a failure in the production of mucus can not be due to an inadequacy of protein, but it might be due to an insufficiency of glycuronic acid. There are apparently two sources of glycuronic acid available to the body, namely, endogenous sources synthesized from glycogenic amino-acids and exogenous sources present in food material. Very great importance must be attached to the exogenous sources under those conditions where the body demands glycuronic acid in larger quantities or at a faster rate than can be produced by endogenous metabolism.

In an attempt to throw further light on the mechanism of mucus production, means were instituted to deplete the glycuronic acid of experimental animals. Rabbits were placed on a diet of oatmeal and water. Three times daily, gradually increasing doses of menthol were administered by stomach tube. Menthol is conjugated with glycuronic acid, and the resulting *menthol-glycuronate* to a large extent is excreted in the urine. As soon as the dosage of menthol increased to the point where it demanded a larger amount of glycuronic acid than could be supplied by either exogenous or endogenous sources, signs of intoxication occurred. Animals surviving from two to four days show upon autopsy ulcerations in the stomach, pylorus, gall bladder, small and large intestine. These ulcers and erosions bear a marked resemblance to those occurring in vitamin A deficiency.

From studies of this sort, the impression has been gained in this laboratory that the fundamental cause of ulcerative and erosive changes in the gastro-intestinal mucosa is due to the presence in the body from any source whatsoever of toxins so constituted that in order for their detoxication they must be conjugated with glycuronic acid. The demands for detoxication evidently take precedence over the demands of mucin production, with the result that when there is a sufficient accumulation of toxins there will follow as sequelae erosion and ulcers in the gastro-intestinal tract. Since the conjugation of glycuronic acid and toxins occurs in the liver any impairment in hepatic function will predispose to an earlier appearance of mucosal damage. It appears that vitamin A is involved somehow in this mechanism. The evidence of Clausen[1] and others that the reserves of vitamin A or its provitamin are nearly, if not entirely, exhausted in septic diseases is not to be explained entirely on the basis of impaired absorption. The fact that it does not seem probable that all the benefit[2] enjoyed by vitamin A deficient animals when fed whole apple is due to vitamin A only is further evidence in this connection. More work is being done along this line and it is hoped that more information will be provided in the near future.

IRA A. MANVILLE

MEDICAL SCHOOL
UNIVERSITY OF OREGON

[1] S. W. Clausen, *Jour. Am. Med. Asn.*, 101: 1384, 1933.
[2] I. A. Manville, A. S. McMinis and F. G. Chuinard, *Food Research*, 1: 121, 1936.

CONCERNING FOSSIL REMAINS OF LEGUMINOUS PLANTS

ONE feature of the symbiotic nitrogen fixation process of the *Leguminosae* which has received little attention is the possibility of finding fossil remains of these plants with patterns of root nodules. Perhaps the survival of nodules through fossilization is not likely, due to the fact that the nodules are vastly more perishable than the root. From the late Cretaceous and early Tertiary times, fossils of leguminous plants have been found but without any mention of the presence or absence of nodules. The very fact that the wide distribution of the *Leguminosae* parallels the age of great mammal development would seem to indicate that these plants have from very early times harbored the bacteria and thus have been active in the fixation of nitrogen. If plant remains with nodules could be found we would have a clue to the early soil-enriching power of these plants.

Knowledge concerning leguminous fossils with special emphasis on nodule formation would be of great interest. The authors would like to get in touch with paleobotanists who have had experience in studying these forms. It is hoped that some one in this field will report his observations.

E. B. FRED
I. L. BALDWIN
ELIZABETH MCCOY

UNIVERSITY OF WISCONSIN

MORE ABOUT SCIENTIFIC ENGLISH

IN a recent note[1] Boring has pointed out that the proper use of English in scientific publications is a matter of good taste, good manners; and suggests that the verbosity and circumlocution exemplified by Urbach in a previous paper[2] are to be judged by such standards. With this point of view I agree. The purpose of English in science is to convey as clearly as possible facts and ideas from author to reader. The trouble with such a criterion is that it implies a certain level of taste which is obviously rather rare. If the literary taste of scientists were well developed, notes on scientific English would not be written.

Scientific phraseology has, however, become so stereotyped that it is possible to single out for general attention and abhorrence specific and often re-

[1] SCIENCE, 84: 457–459, 1936.
[2] *Ibid.*, 390–391.

peated crimes against good English. Run your eye down a page or two of scientific writing and observe the recurrence of "thus." Strike it out everywhere, or almost everywhere, and notice the improvement. It is as if the writer is afraid that the connection of his ideas is not plain, and so "thuses" his way laboriously from sentence to sentence. Even commoner is "case." If you examine our current works on biology, you will find that they deal not with plants or animals but with their "cases." You will read that "in the case of Rhizopus the mycelium is aseptate," which means presumably that "the mycelium of Rhizopus is aseptate." A case is really a chance or event (aside from its specialized legal and medical uses), and is rarely needed in the sentences where it occurs. It may be entirely eliminated, or replaced by "organism," "species," "experiment" or whatever was really meant. Such a lack of precision and organization of thought is pardonable in rapid speech, but regrettable in writing.

Aside from the matter of taste, there are certain rules of grammar and syntax which, after all, deserve some respect. That clumsy and ubiquitous phrase quoted by Urbach, "due to the fact that," is not only verbose but, as commonly used, ungrammatical; "due" is not a conjunction. Why these five words should replace, incorrectly, the single perfectly respectable word "because" is a mystery, except perhaps to the journalists who invented the trick.

It is somewhat invidious to quote the mistakes of others, but a sentence like the following (which is not exceptional) illustrates the reality and the seriousness of the need for some attention to English: (The individual) "may disappear wholly from the community, as in *the case of the chestnut, due to blight,* though *this* is relatively rare." (Italics are mine.) The "case of a chestnut" should be the spiny fruit, though it is difficult to conceive how it can be "due to blight." Whether blight, chestnuts or the disappearance of chestnuts is rare is left to the imagination—or taste—of the reader.

H. W. RICKETT

UNIVERSITY OF MISSOURI

SCIENTIFIC BOOKS

THE PAPERS OF SIR WILLIAM HARDY

Collected Scientific Papers of Sir William Bate Hardy. Published under the auspices of the Colloid Committee of the Faraday Society. Cambridge University Press, 1936. 922 pp. $18.00.

THE "Collected Scientific Papers of Sir William Bate Hardy" are especially important for an era in which subjects for scientific research tend more and more to be determined by administrators or their committees and less and less by the unhampered imagination of the scientist. Sir William Hardy's first paper in 1891 was "On some Points in the Histology and Development of *Myriothela phrygia.*" In his last papers in 1933–34 he was still concerned with the problems of biology. Meanwhile, interested in systems characteristic of living matter, he concerned himself first with the chemistry of the proteins, then with the physical properties of films and of the boundary state. Although constantly employing the methods of physics and chemistry he was never an "applied scientist." Rather his inquisitive mind found new fields for exact investigation at the interface between biology, physics and chemistry.

Biologists often require for the solution of their problems a physics and a chemistry which has not yet been completely developed. As a consequence not only are advances made as a result of applications of physics and chemistry to biology, but biologists contribute innumerable new concepts, substances and principles to physics and chemistry. Often a Helmholtz or a Hardy contributes first to physiology and then to physics.

The first ten of the collected scientific papers of Sir William Hardy are concerned with morphology. The eleventh published in 1894 was a "Note on the Oxidising Powers of different Regions of the Spectrum in Relation to the Bactericidal Action of Light and Air." The bactericidal action of light having been demonstrated to be the peculiar property of light of short wave-length, Hardy characteristically investigated the relation of this phenomenon to the presence of some oxidizing substance acted upon by the blue and violet portion of the spectrum. For Hardy an observation was always a stimulus to the investigation of the underlying mechanism.

In 1899 appeared the last of the morphological papers: "On the Structure of Cell Protoplasm." Precisely because he was trained as a morphologist Hardy was in an admirable position to conclude "that the various fixing reagents are coagulants of organic colloids and that they produce precipitates which have a certain figure or structure" (p. 250). "Reagents which have any action at all confer a structure upon the colloidal matter which differs in most cases in kind, in some cases in degree, from the initial structure. Hence it is inferred that the structure seen in cells after fixation is due to an unknown extent to the action of the fixing reagents" (p. 291–292).

The conclusion that the structure of the living cell could only be deduced from the structure of dead mat-

ter if one knew not only the influence of the chemical reagents employed by the histologist but also the "coagulation (clotting) phenomena of death, as well as . . . post mortem change" (p. 292) led Hardy to turn his attention to the phenomena of coagulation and especially to those molecules of the body that are most readily coagulated: the proteins. In 1899 the transition is made from histology to chemistry. The next fourteen papers, appearing over the period ending in 1912, are concerned largely with colloidal solutions, especially with proteins.

The first paper of this series "On the Coagulation of Proteid by Electricity" in 1899 is a classic. With clarity and insight Hardy correctly interpreted the scattered information in the literature regarding the charged condition of matter and correctly deduced the amphoteric properties of the proteins. He noted that "Under the influence of a constant current the particles of proteid in a boiled solution of egg-white move with the negative stream if the reaction of the fluid is alkaline; with the positive stream if the reaction is acid" (p. 307). All subsequent work upon this important class of molecules follows from this observation. The work started in 1899 led to several remarkable papers, two of which on globulins appeared in 1905, one in the *Journal of Physiology,* the other as the Croonian Lecture of the Royal Society of that year. "Globulins are a class of proteids which occur in both animal and vegetable tissues. They are peculiar in the complexity of their relations to electrolytes. Insoluble in water, they are soluble in low concentrations of acids, alkalis, or neutral salts. In presence of acids the globulin is electro-positive, in presence of alkalis it is electronegative, in presence of neutral salts it is electrically neutral. . . . The problem I propose to consider is their diversified relation to electrolytes" (p. 430).

These papers teem with incisive original observations which, however much they have been amplified in the last 30 years, have not in any important sense required reinterpretation. In them are to be found the concept of the isoelectric point and of the stoichiometric relations of proteins to acids and bases, deduced from measurements of conductivity, viscosity and electric transport of globulin ions, and the relations of the various ionic states of globulin, as well as of neutral globulin, to neutral salts.

The development of a theoretical understanding of the behavior of globulins in well-defined systems did not however replace his interest in the state of protein in nature. "The proteids of serum are electrically inactive. Neither the whole nor any fraction moves in a field. It is not possible to detect a trace of "ionic" proteid. Dialysis or dilution disturbs the equilibrium, and "ionic" globulin appears" (p. 418). "The probability of globulin being formed owing to the decomposition of a complex proteid present in serum is urged" (p. 426). However far from his morphological interests his studies of colloidal solutions seemed to take him, he was always concerned in his study of globulins with the problem of the state of matter in nature.

The study of the movement of proteins in an electric field led many biologists to investigate "the movement of free living cells suspended in a fluid through which an electric current is passing" (p. 490). The results reported on cells were as conflicting in 1911 as were those on molecules in 1899 and Hardy felt impelled to caution that "the movement of living cells, or indeed of any suspended particles, in films of liquid a millimeter or less in depth enclosed between glass plates is not open to simple interpretation" (p. 490). By 1911 Hardy's grasp of the chemical and physical problems as they related to the charged condition of matter had reached a point where he perceived the implications of the electrical density at interfaces and of the dimensions of molecules and surface layers.

In 1911 therefore, as in 1899, Hardy again changed the nature of his investigations. His work from this time on is for the most part concerned with the physical properties of matter at interfaces. Although his interest remains that of the biologist, as is attested by his papers on "Some Problems of Living Matter," "Living Matter" and "Molecular Orientation in Living Matter," he investigated such problems as "The Influence of Chemical Constitution upon Interfacial Tension," "The Spreading of Fluids on Glass," "Boundary Lubrication," "Chemistry at Interface" and "Problems of the Boundary State."

At each level of his understanding Hardy reverted to his primary interest, and the last of the collected papers is "To Remind: a Biological Essay." In this interesting lecture he warns against certain tendencies in modern science. His words have the wisdom always associated with him by his colleagues, but more important is the example he set by his scientific life. His collected writings, beautifully published under the auspices of the Colloid Committee of the Faraday Society, are a lasting memorial to him, and for us the detailed "history of a mind" such as is not likely often to appear in our times.

EDWIN J. COHN

HARVARD MEDICAL SCHOOL

VASCULAR PLANTS

Morphology of Vascular Plants; Lower Groups. By ARTHUR J. EAMES. McGraw-Hill. 1936. $4.00.

A NEW understanding of the comparative anatomy and morphology of vascular plants is one of the more recent developments in the progress of botany. Unlike the highest animal group, the vertebrates, in which

the comparative body plan has been appreciated for hundreds if not thousands of years, in the highest plant group there has been no ready key to the comparative unity of structure.

In Professor Eames's book, we have an important contribution to the general understanding of the comparative anatomy and phylogeny of vascular plants. It sums up the findings and conclusions of anatomical and paleobotanical research, a considerable part of which has been contributed during the past thirty-odd years. Several basic conclusions are presented which, if finally validated, will displace general concepts of long standing. These may be noted as follows:

(1) Vascular plants are all grouped together in one phylum, the Tracheophyta. The current division into two phyla, Pteridophyta and Spermatophyta, goes the way of the earlier separation into Cryptogamia and Phanerogamia. The seed habit is recognized as having arisen independently in more than one line of vascular type.

(2) The phylum of tracheophytes is divided into four main groups, largely on the basis of stelar and foliar differences. E. C. Jeffrey was the first to propose a division on this basis, in 1901. He divided vascular plants into two main groups, the Lycopsida and the Pteropsida. The Pteropsida comprised all true ferns and the higher seed plants, all those with large leaves which leave a gap in the vascular cylinder at the point of origin.

In the Lycopsida, he grouped the remaining vascular plants, based on a simpler stelar structure and the absence of foliar gaps. Subsequent workers have split Jeffrey's Lycopsida into three groups; the Lycopsida proper, taking in Lycopodium, Selaginella and similar fossil types; the Sphenopsida, including modern Equisetum and the Paleozoic sphenophyls; and the Psilopsida, with living Psilotum and Tmesipteris and similar Paleozoic forms.

(3) The archetypal vascular plant body is not to be considered as consisting of the three parts, root, stem and leaf. Instead, based on some rather recent paleobotanical work which has reported the structure of Silurian fossils, it is concluded that the primitive, terrestrial, vascular plant had a dichotomously branching axis, partly hypogean, partly epigean, bearing sporangia, but without leaf or root differentiation. Psilotum and Tmesipteris are the modern representatives of this plant form. Psilophyton, Rhynia were among the earliest pre-Carboniferous types.

(4) The long-standing controversy regarding the homologous or antithetic origin of alternation of generations is considered settled in favor of the former principle. The vascular sporophyte has not been derived by the progressive sterilization of a diploid sporangium, but rather by the gradual modification of a thalloid branch system.

(5) Finally, as a corollary of the preceding point, leaves of tracheophytes are recognized as having had two different origins. Those of the lycopsid type are regarded as enations; those of the larger sort, which leave gaps in the stele, are considered to have come from branch systems, become lateral and secondary by sympodial development. The dichotomy of fern venation would represent the persistence of a primitive branch condition.

All these several conclusions sum up into one broader concept, *viz.*, that vascular plants were originally derived directly from some thallophyte ancestor, and not by way of an intermediate bryophyte stage. The latter would constitute a separate line of terrestrial development from the algae.

Not all botanists will be ready to accept these conclusions. Not only will there be delay, due to natural conservatism, and to the difficulty of effecting so radical a change in thought from what has come to be familiar and traditional. Some botanists will prefer the antithetic theory of alternation and possible liverwort ancestry for vascular plants, a view so long and ably upheld by Campbell and Bower. Thus, Brown, in a recent and excellent elementary text in botany (Ginn, 1936), reaches the conclusion that "the structure of the Psilophytales fits in very well with the long-accepted idea that the Pteridophyta are derived from the Bryophyta."

On the other hand, the newer point of view has found expression in the general texts of Torrey (1930) and Sinnott (1935). In Germany, Zimmerman's "Die Phylogenie der Pflanzen" is even more comprehensive than the Eames.

R. C. BENEDICT

BROOKLYN COLLEGE AND
BROOKLYN BOTANIC GARDEN

THE NATIONAL ACADEMY OF SCIENCES. II

ABSTRACTS OF PAPERS PRESENTED AT THE CHICAGO MEETING

A comparison of differential heats of dilution with the predictions of the theory of Debye and Hückel: T. F. YOUNG (introduced by W. D. Harkins). Differential heats of dilution to be used in combination with cryoscopic measurements for the evaluation of activity coefficients of sodium chloride, in aqueous solution, have recently been determined. Significant discrepancies were encountered when the new measurements were compared with published differential heat of dilution data derived from experiments with extremely dilute solutions. Those data were also in conflict with the Debye-Hückel theory which permits a theoretical calculation of

the limit, as the molality approaches zero, of the derivative of the apparent molal heat content with respect to the square root of the molality. Both discrepancies proved to be due to calculations based upon an unjustified assumption, and both disappeared when adequate mathematical methods were applied to the calculation of the derivative. The same methods have now been applied to existing measurements of the heats of dilution of solutions of the halides, halates, nitrates and sulfates of the alkali metals. The new estimates of the limits of the derivative are in good agreement with theory. In nearly as good agreement are the values of the limiting derivatives calculated for the halides and nitrates of the alkaline earth metals. The very satisfactory agreement with theory of the behavior of a large number of electrolytes is in striking contrast with the behavior of a few, whose derivatives rise with decreasing molality, to values much larger than theory predicts. These include sulfuric acid, and the sulfates of calcium, magnesium, copper, zinc and cadmium. The sulfuric acid data can be explained by an increasing dissociation of the bisulfate ion with decreasing concentration. To be consistent with this explanation, the derivative curve should possess a maximum, the position of which is dependent upon the dissociation constant of the bisulfate ion. There is, at present, some evidence that such a maximum actually exists in the derivative curve of calcium sulfate.

Configuration changes in the reactions of complex inorganic compounds: JOHN C. BAILAR, JR., E. H. HUFFMAN and A. R. WREATH (introduced by William A. Noyes). Compounds of the octahedral configuration $[\mathrm{Men_2A_2}]$ and $[\mathrm{Men_2AB}]$ ("M" represents a metal, "en," ethylenediamine and "A" and "B," singly coordinated groups) can exist in *trans* forms and in optically active *cis* forms. In the replacement of A and B by other groups, there can be configuration changes in the cis-trans sense, as well as changes from one cis configuration to the other. This type of reaction is being studied in the author's laboratory in the hope of throwing some light upon the mechanism of the Walden inversion. The current theories of the Walden Inversion are based upon the behavior of organic substances and can not explain the cases under discussion. The reaction *levo* $[\mathrm{Coen_2Cl_2}]\mathrm{Cl} \rightarrow$ *levo* or *dextro* $[\mathrm{Coen_2(NH_3)_2}]\mathrm{Cl_3}$ goes through the intermediate $[\mathrm{Coen_2Cl(NH_3)}]\mathrm{Cl_2}$. It has been shown that the inversion does not take place in the second step. The first step is now under investigation. The coordinated chlorine groups of $[\mathrm{Coen_2Cl_2}]\mathrm{Cl}$ have been replaced by several other groups under a variety of conditions. In only two cases has it been demonstrated that optical inversion takes place, but it may have taken place in others. Some reactions of the chromium compound $[\mathrm{Cren_2Cl_2}]\mathrm{Cl}$ have also been investigated. The coordinated chlorine groups are not readily replaced, and no inversion could be demonstrated.

Catalytic effect of ammonium salts on the ammonolysis of diethylmalonate in liquid ammonia: L. F. AUDRIETH and C. SLOBUTSKY (introduced by William A. Noyes). Solutions of ammonium salts in liquid ammonia have been shown to possess the characteristic chemical properties of acids. Just as acids exert a catalytic effect upon hydrolytic reactions, so it was to have been expected that ammonium salts would influence ammonolytic reactions, that is, reactions involving the action of ammonia as solvent upon dissolved solutes. The authors have shown that the ammonolysis of diethylmalonate is markedly catalyzed by the presence of ammonium salts. This effect is a function of the concentration of the catalyst. Equivalent concentrations of various ammonium salts exert the same catalytic effect.

Distribution of chromosomal prime types in Datura stramonium: A. F. BLAKESLEE, A. D. BERGNER and A. G. AVERY.

The effect of dehydration on the exchange of salt and water between muscle and blood: LILLIAN EICHELBERGER (introduced by H. G. Wells). Experiments on normal dogs are described in which the extra- and intracellular phases of muscle were studied following (1) intravenous injection of hypertonic sodium chloride or sucrose and (2) intraperitoneal injection of (a) isotonic glucose or (b) sucrose or (c) hypertonic sodium chloride. From these data the following conclusions have been drawn: (1) Following the injection of hypertonic solutions, either intravenously or intraperitoneally, the original kilogram of muscle decreased in volume with an increase in the extracellular phase and a marked shrinking of the muscle cells. The maximum shrinkage occurred immediately following the intravenous injections. (2) For four hours following the intraperitoneal injection of isotonic glucose or sucrose the original kilogram of muscle decreased in volume. Both the extra- and intracellular phases lost water during this period of time.

Plasmapheresis, plasma exudation and traumatic shock: HENRY N. HARKINS (introduced by W. D. Harkins). Aside from nervous and toxic factors, a loss of actual fluid from the circulating blood stream has been found in certain types of shock. In some instances this fluid loss consists in whole blood, but in others it more nearly resembles blood plasma. Discussion is made of the quantitative relationship between the amount of blood lost during fatal hemorrhage, the amount of plasma lost during plasmapheresis and the amount of plasma-like fluid that exudes from the blood vessels in certain types of shock.

Respiratory phenomena in a case of dementia praecox: S. SLIGHT (introduced by H. G. Wells).

The nature of disease resistance in plants: F. C. WALKER (introduced by L. R. Jones).

The mechanism of immunity to Nippostrongylus muris, the intestinal nematode of the rat: W. H. TALIAFERRO and M. P. SARLES (introduced by F. R. Lillie). Although acquired immunity has been shown to develop following infection with *Nippostrongylus muris* by many investigators, evidence as to the mechanism of this immunity has been meager. We have found that acquired immunity to this parasite has to a large extent an antibody basis, since

it is passively transferable. Moreover, in the actively immune rat, there is a more rapid and intense inflammatory response than in the normal animal. Thus, the infective larvae attempt their usual migration from the skin to the intestines via the lung in the immune animal, but become coiled up and immobilized, probably because of the presence of antibody, within the first few hours after they reach the skin and the lungs, and become the center of an inflammatory reaction which consists mainly of eosinophils and hypertrophying agranulocytes of hematogenous origin. Such worm-nodules increase steadily in size by the addition of cells at their periphery, within which the parasites eventually disintegrate and are phagocytosed. At later stages, the worm-nodules become tubercle-like masses of cells with a precipitate around the anterior end of the worm. Some of the worms are able to escape from the nodules of the skin and lungs before this occurs, but although they migrate to the intestine of the rat, are mostly passed from the intestine without developing to maturity or laying eggs. So far the only difference we have found in the intestine between normal and immune animals is a great increase of connective-tissue basophils and eosinophils in the *lamina propria* in immune animals, the significance of which is not evident. In the skin and lungs of immune animals, there is, therefore, evidence of antibody action (immobilization of worms and formation of precipitate in and at ends of larvae) and a mobilization of host-cells which eventually remove the disintegrated worms. In the intestine, there is also evidence of antibody action (stunted growth) and mobilization of host-cells, but the exact function of the latter is obscure.

Immunogenetic studies on species relationships: M. R. Irwin and L. J. Cole (introduced by Ludvig Hektoen). Studies from this laboratory have shown (a) that there are hereditary biochemical characters in the red blood cells of a species which distinguish its cells from those of any other species, and (b) that such characters are separable in the cells of backcross offspring from hybrids between the two species. This shows that these genetic differences between species are of the same order as those within a species. There appears to be a correlation between the presence of these species-specific characters and the amount of fertility displayed by the backcross offspring. It is possible by an extension of these methods to analyze for a species the extent to which its specific cellular characters are shared with other species. Eventually this should provide an assay of the phylogenetic relationships between species.

The relative susceptibility of the mammalian fetus to infectious agents: Oram C. Woolpert and N. Paul Hudson. A study of the immunologic state of the adult animal is complicated particularly by two circumstances: (1) the immunologic make-up of the adult has been conditioned by countless past contacts with antigenic substances; (2) the adult is exposed during experimentation to a variety of potentially infectious and immunising agents. The mammalian fetus, on the other hand, has had little contact with infection and occupies a sterile environment. Therefore, if responsive to infectious agents, it should offer conditions highly suitable for the investigation of certain immunologic problems. In pursuing this concept, a group of us has been studying the susceptibility of guinea pig and rabbit fetuses to parasites directly inoculated, particularly *Mycobacterium tuberculosis*, *Actinomyces bovis* and the viruses of vaccinia, herpes, poliomyelitis and the submaxillary gland disease of guinea pigs. The observations made in these studies were: (1) Whenever the adult of the host species was at all responsive to the particular agent, the fetus was usually much more susceptible. (2) Younger fetuses appeared to be more susceptible than older fetuses. (3) Fetal reactions to a particular parasite resembled those of the adult with respect to incubation period, organs affected, appearance of cellular inclusions, etc. However, the reaction in the fetus was often more acute and the pathologic changes more widely spread. (4) The infective agents, with certain exceptions, were not altered in their biologic properties by fetal passage. The basis for the low resistance of the fetus as compared with the adult may be due in part to (a) absence of humoral antibodies because of lack of previous exposure, (b) deficient cellular reactivity early in fetal life, (c) the possible presence of enzymatic or other substances associated with rapidly growing embryonic tissue, which may favor parasitization.

Transformation of organic designs: paleontologic aspects of organic evolution: William King Gregory.

Problems in the chemistry of boron hydrides as illustrated by the newly discovered compounds B_2H_7N and BH_3CO: H. I. Schlesinger and A. B. Burg (introduced by W. D. Harkins). The aim of the investigations of the hydrides of boron, of which the present paper is a part, is twofold: (1) to aid in establishing structural formulae which will clarify the abnormal valence relations exhibited by boranes, and (2) to determine whether normal boron hydrides (*e. g.*, BH_3 or B_2H_4) are capable of existence. The work herein reported illustrates the type of approach employed in each problem. The new compound B_2H_7N is prepared and characterized. Its properties, particularly the fact that it takes up only one mole of ammonia instead of two to form a stable compound, are not those of an amine of diborane, $B_2H_5NH_2$. Two formulae

$$\left[\mathrm{H}:\overset{\mathrm{H}}{\ddot{\mathrm{B}}}::\overset{\mathrm{H}}{\ddot{\mathrm{B}}}:\overset{+}{\mathrm{N}}\mathrm{H}_3\right]^{-}\mathrm{H}^{+} \quad \text{or} \quad \left[\left(\mathrm{H}:\overset{\mathrm{H}}{\ddot{\mathrm{B}}}:\underset{\mathrm{H}}{\overset{\mathrm{H}}{\ddot{\underset{\cdot\cdot}{\mathrm{B}}}}}:\overset{+}{\mathrm{N}}\mathrm{H}_3\right)^{-}\right]$$

are suggested, and their bearing on the valence problem of diborane is discussed. By the reversible action of carbon monoxide on diborane, the new compound $BH_3 \cdot CO$ is obtained. It is shown to react with trimethylamine to form carbon monoxide and another new compound $BH_3 \cdot N(CH_3)_3$. These reactions and other properties of the compounds suggest that they are complexes containing hitherto unknown monoborine. On the other hand, the compound $BH_3 \cdot CO$ reacts with ammonia, not to liberate carbon monoxide and form $BH_3 \cdot NH_3$, but to add two moles of ammonia without loss of carbon monoxide. It is expected that further study of these substances will lead to an understanding of the relations between monoborine (BH_3) and diborane (B_2H_6).

A new method of determining the ring structures of glycosides: C. S. HUDSON and ERNEST L. JACKSON. The oxidation of several methyl glycosides has been found to yield crystalline salts of several derivatives of di-glycolic acid, the structures of which have been determined. These structures show in turn the ring structures of the parent glycosides. By this method the ring structures of the alpha form of methyl glucoside, methyl mannoside, methyl galactoside, methyl guloside and the alpha and beta forms of methyl arabinoside and methyl xyloside are shown to be of the pyranose type. A new crystalline methyl arabinoside has similarly been shown to be of the furanose type and of the alpha configuration.

A new and problematical cat-like fossil from the Eocene: W. B. SCOTT.

Contribution to the knowledge of Pleistocene vegetation in Minnesota: C. O. ROSENDAHL (introduced by A. J. Carlson). The occurrence of plant remains of Pleistocene age have been reported from 35 counties in Minnesota. A majority of the 65 recorded stations are located in the southern and western parts of the state and are distributed from near the eastern edge of the drift to the Canadian border in the Red River valley. A good deal of the plant material discovered prior to 1920 came from wells, being found at depths ranging from 10 to 195 feet, and only tentatively identified as oak, elm, cedar, tamarack or sticks, leaves and peat. Nearly all the material obtained recently, with one notable exception, has been found in road cuts or other deep excavations incident to industrial activities. Most of it is wood, in a fair to excellent state of preservation, occurring in the Nebraskan till and therefore either of preglacial or Aftonian interglacial age. There is a great preponderance of white and black spruce in the wood from the Nebraskan till, but several species of Dicotyledons are also represented. The richest deposit of Pleistocene plants in Minnesota has come from a deep well in Kittson County in the bed of Glacial Lake Agassiz. At a depth of 88 feet, and at the bottom of the Late Wisconsin till, a layer of ancient vegetation was struck that has yielded pieces of lignite, charcoal, innumerable pieces of wood, mosses, cones and nearly 600 fruits and seeds of Angiosperms. From this material there have been identified 6 genera of mosses, 4 conifers and 38 species of Monocotyledons and Dicotyledons. Many of the pieces of wood show a striking coincidence in the greatly reduced width of the annual rings towards the periphery of the stems. Very short growing seasons are indicated for the last 20 years of the life of the trees.

Paleobotanical research at the University of Chicago: A. C. NOÉ (introduced by F. R. Lillie). Paleobotanical research at the University of Chicago was established in the year 1921. It has developed along two distinct lines: a morphologic study of fossil plant structure and an investigation of fossil plant deposits with reference to problems of floral evolution, paleoclimatology and paleogeography. In recent years the field of our fossil plant exploration has been extended to distant regions in the United States and Mexico and much new structural material has been discovered.

Pre-glacial plant relics in the driftless area: NORMAN C. FASSETT (introduced by L. R. Jones). The Driftless Area, not invaded at any time by the Pleistocene glaciation, is entirely surrounded by glaciated territory. The flora of the glaciated regions is of course entirely postglacial, derived for the most part from survivors south of the glacial margin. But there is evidence that in spite of proximity of the ice some species continued to exist in the Driftless Area throughout the Wisconsin glaciations if not during all the Pleistocene. Thus we find *Montia Chamissoi* ranging from Alaska to New Mexico, with two isolated stations a thousand miles to the east in the Driftless Area. We see *Sullivantia Sullivantii* existing to-day just south of the glacial territory from Missouri to Ohio, and also in the Driftless Area, having obviously been exterminated between these two regions by glacial action. *Dodecatheon amethystinum* is confined to the Driftless Area, except for isolated stations in parts of Missouri and Pennsylvania which escaped the glaciers. In *Hypericum Kalmianum* is an example of a plant which survived glaciation in the Driftless Area, then followed a line of glacial lakes northeastward through the Fox River valley to Lake Michigan, and migrated around the Great Lakes shores.

Objectives of chlorophyll research: C. F. KETTERING.

The absorption spectra of solutions of pure chlorophyll and of chloroplasts in living cells: V. M. ALBERS and H. V. KNORR. This investigation was undertaken to determine whether the absorption spectra of chlorophylls separated by the Willstätter methanol procedure were identical with the spectra of the chlorophylls separated by selective adsorption on sugar. All the chlorophyll was taken from a single original sample and showed a positive Molisch reaction, satisfied the cleavage and basicity tests and had a magnesium content of 2.7 per cent. Absorption spectra of the original chlorophyll *a* and *b* mixture and the two mixtures, made by mixing the two components separated by the above procedures in the proportion of three parts of *a* to one part of *b*, were determined by the method previously described.[1] These spectra indicate that, while the positions of the absorption bands in the visible region fall in very nearly the same positions in all three cases, the magnitudes of the absorption coefficients are quite different. The chlorophyll which had been treated by the method of selective adsorption on sugar showed a much greater difference from the original than that treated by the Willstätter methanol procedure. These results indicate quite definitely that the chlorophylls are changed in some way during the process of separation and that the changes produced vary with the method of separation. They also indicate that the use of the known chemical tests and the positions of the visible absorption bands are not sufficient criteria for comparison of two samples of chlorophyll. In order to eliminate the complicated scattering encountered in the living leaf, the absorption spectra of single chloroplasts were photographed, using a Hilger E,

[1] V. M. Albers and H. V. Knorr, *Jour. Chem. Phys.*, 4: 422–425, 1936.

spectrograph. The chloroplasts used were those in cells of Protococcus, Spyrogyra and Zygnema. They were mounted on the stage of the microscope and critically illuminated by means of a ribbon filament lamp. The image of the chloroplast was projected on the slit of the spectrograph, using a 4 mm objective with no ocular on the microscope. The plates were calibrated and absorption curves determined for the region from 704 mμ to 665 mμ. The region of absorption is found to be the same as that reported for the entire leaf. However, instead of a single band, four maxima, located at 668 mμ, 673 mμ, 678 mμ and 683 mμ, were observed. The relative intensities of these maxima are different in different chloroplasts, even in the same species.

Recent advances in the chemistry of chlorophyll: PAUL ROTHEMUND (introduced by C. F. Kettering). During the past few years the chemical research in the field of chlorophyll has led to a very intimate knowledge of the chlorophyll structure. It was demonstrated by Fischer that the isocyclic ring system attached to the hydrogenated porphin ring is responsible for a number of typical reactions of the pigment. One methylene group in chlorophyll and in its derivatives was found to be extremely reactive, as long as the magnesium atom was complexly linked to the molecule. Stoll observed the optical activity of chlorophyll solutions in monochromatic polarized light. It was possible for Fischer to prove that the "phorbin" system in chlorophyll contains two hydrogen atoms more than the porphin system. The same author identified a vinyl group in the molecule of chlorophyll *a* and *b*, and he also performed the partial syntheses of the following chlorophyll derivatives: chlorophyllide *a*, methyl chlorophyllide *a*, ethyl chlorophyllide *a* and pheophytin *a*. Our own synthetic work to obtain "porphin", the fundamental ring system of chlorophyll and of hemin, was successful: porphin and a large number of its derivatives and homologues were prepared synthetically by condensing pyrrole with suitable aldehydes. An interesting case of isomerism of porphyrins was found in connection with this synthesis. The syntheses of hydrogenated porphin and of the hydrogenated porphin ring in form of "phorbin" have not been accomplished so far. Our studies on the precursor of chlorophyll in plants led to the isolation of a green pigment, which is closely related to chlorophyll in elementary composition and in spectroscopic properties. The formula (Fig. 1) given herewith is the best expression of our present knowledge of the structure of chlorophyll *a;* in chlorophyll *b* the $-CH_3$ group attached to ring II is replaced by the formyl group $-C{=O \atop -H}$.

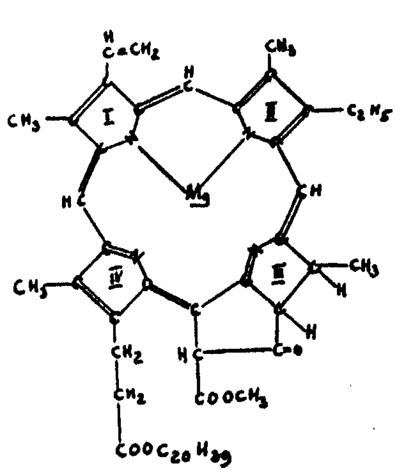

FIG. 1

The ratios of chlorophyll a and b and the mechanism of photosynthesis: ONDESS L. INMAN (introduced by C. F. Kettering). Sorby in 1872 investigated the proportions of chlorophyll *a* (blue chlorophyll) to chlorophyll *b* (yellow chlorophyll). He reported 100 parts of *a* to 0 of *b* in the olive and red algae. Leaves grown nearly in the dark showed a ratio of 100 parts of *a* to 5 or 6 parts of *b*. Healthy green leaves gave 100 parts of *a* to 13 to 17 parts of *b*. Willstatter studied many green plants and found on the average about three parts of chlorophyll *a* to one part of chlorophyll *b*. The brown algae ratio was found to be 19 parts of *a* to one part of *b*. It has been found that when the etiolated leaf of *Zea Mays* is irradiated for two and one half hours and the first evolution of oxygen detected by use of luminous bacteria, the ratio of chlorophyll *a* to chlorophyll *b* is 21.7 parts of *a* to one part of *b*. When the time of irradiation was four hours the ratio was 17.4 parts of *a* to one part of *b*. This indicates that the normal ratio of three parts of *a* to one part of *b* is not essential for photosynthesis, if one assumes that the process of photosynthesis is under way when the evolution of oxygen can be detected. Furthermore, it is reasonable to conclude that any theory of photosynthesis which supposes an equilibrium reaction between chlorophyll *a* and *b* should not require a constant value for the components *a* and *b*. If chlorophyll combines chemically with carbon dioxide, as has been postulated, such data would tend to point toward an assured combination with chlorophyll *a*. If, however, chlorophyll *b* does play the same part as *a*, then it seems most logical to assume that the part of the chlorophyll molecule which combines with carbon dioxide is a portion common to both chlorophyll *a* and chlorophyll *b*, such as, for example, magnesium or the additional five ring component or the phytyl group or some additional part of the natural occurring molecule which is not found in the purified product.

Spectroscopic analysis of hemochromogens: the ferriheme hydroxide-cyanide equilibrium: T. R. HOGNESS, F. P. ZSCHEILE, JR., A. E. SIDWELL, JR., and E. S. G. BARRON (introduced by W. D. Harkins). A precise spectrophotometric method makes possible the analysis of mixtures of hemoglobin derivatives, and consequently the study of equilibria involving these compounds. One of the equilibria studied is that between ferriheme hydroxide and cyanide ion. This study shows definitely that the ferriheme hydroxide is an associated compound and reacts to form ferriheme cyanide, according to the equation,

$$Hm_2(OH)_2 + 4\,CN^- = 2\,Hm(CN)_2^- + 2\,OH^-.$$

This is the first experimental evidence for the association of the ferriheme radical. On the basis of the accepted structure of ferrihemochromogens, there is no apparent explanation for the linkage which accounts for this association.

X-ray studies of the structures of biological materials: GEORGE L. CLARK (introduced by W. A. Noyes). Briefly outlined are the improvements in x-ray diffraction technique which have permitted studies of substances produced in living processes. Primary among these improvements is the resolution of interferences corresponding to very large periodicities—for example, 440 A. U. in collagen. Latest results are summarized on cellulose, chitin, rubber, keratin (human hair, feathers, pig bristle), living nerve, tendon collagen, intestinal wall collagen, muscle, albumin, hemoglobins, cereal proteins, etc. As an example of the usefulness of the diffraction pattern in biological research is cited the 48 A. U. equatorial spacing in intestinal wall collagen which led to the isolation, purification and analysis of a wax-like substance whose molecules are oriented radially on the fibrils and serve both to "lubricate" the fascial tissue and to protect the protein from enzyme digestion.

Slow ionic oxidation-reduction reactions: their mechanism and catalysis: PHILIP A. SHAFFER. Although many ionic reactions are immeasurably rapid there are numerous cases where thermodynamically possible reactions between demonstrably "active" ions are surprisingly slow or even fail to take place without catalysts. In some cases ionic reactions proceed much faster when *separated* in the form of a battery (electro-chemical cell) than when in a single solution. Survey of a number of cases among oxidation-reduction reactions indicates that a simple but hitherto unconsidered quality of the individual ions is frequently an important rate-controlling factor, and appears to explain this strange behavior: namely, the equality or inequality of permissible valence-change. Rapid reactions probably result always from *bi*molecular collisions or a sequence of these. In oxidation-reduction reactions the transfer of electrons from reductant to oxidant requires (in a bimolecular process) "common consent" as to the number to be lost and accepted. Disagreement, because of inability to assume the resulting "impossible" valence state, makes the reaction depend upon third or higher order collisions which are much less frequent events. Like or unlike charge of ions is another factor of less importance. A survey of the periodic table with respect to reactions of elements known in plural valence states indicates many instances which appear to support this simple hypothesis. Greater consideration of characteristic properties of the individual ions, in addition to the present concept of energy levels and "activation energy," is advocated as necessary for progress in the still obscure subjects of chemical kinetics and catalysis.

The rôle of the macrophage in the mechanism of recovery from experimental lobar pneumonia in the dog: O. H. ROBERTSON (introduced by F. R. Lillie). Recent observations on the histological pathology of experimental pneumococcus lobar pneumonia in the dog have shown that the onset of recovery is accompanied by a change in the character of the intra-alveolar cellular exudate from a predominantly polymorphonuclear to a large mononuclear type of cell. These latter cells are for the most part typical macrophages and appear to be derived to a considerable extent from the fixed tissue cells of the lung parenchyma. Associated with this cellular change is a diminution or complete disappearance of pneumococci, due apparently to their phagocytosis by the macrophages. That the mobilization of the macrophages in the lung plays a significant rôle in the termination of the disease is attested by the following experimental findings: (1) The disappearance of pneumococci from lesions in which resolution is occurring during the active phase of the disease when spread of the inflammatory process to other parts of the lung is taking place. (2) The demonstration that the resolving lung constitutes a lethal environment for actively growing, freshly introduced virulent pneumococci. The lung loses this property to a considerable extent upon its return to a normal histological appearance. (3) Studies of macrophage exudates both *in vivo* and *in vitro* have shown that these cells are capable of destroying large numbers of ingested pneumococci within a few hours and that they carry on this process much more effectively than do the polymorphonuclear leucocytes in the presence of relatively weak opsonic fluids.

Some chemical properties of an essential growth factor for pathogenic bacteria: FELIX SAUNDERS and STEWART A. KOSER (introduced by H. G. Wells). Many bacteria, especially the pathogens, develop quite readily in a meat infusion culture but are unable to grow in a simple synthetic medium. If a meat infusion is shaken with charcoal the growth-promoting substance(s) is absorbed and the infusion will no longer support the growth of pathogens. If the charcoal is extracted with boiling alcohol the growth-promoting factor can be eluted and if it is added to a synthetic medium containing inorganic salts, dextrose and amino acids the pathogens will grow. Control tests show that growth is due to a true growth factor and not to the addition of some nutrient to the medium. The growth factor is widely distributed, since it can be isolated from many different kinds of tissue of both plant and animal origin. It is active biologically in extremely small amounts. Only a few gamma are necessary to activate a liter of synthetic medium. Chemical studies show that the growth factor is a substance of low molecular weight. Its most striking property is a remarkable stability. It is heat-stable, resistant to strong oxidants, acids and alkalis. Growth-promoting activity is not destroyed by bromine, ammoniacal silver, acetic anhydride or nitrous acid. The substance is soluble in acetone, methanol, ethanol and phenol but is insoluble in ether, benzene, chloroform and higher alcohols. It does not contain sulfur and is probably inorganic since it is destroyed by ashing.

Experimental meningococcal infection: C. PHILLIP MILLER (introduced by Ludvig Hektoen). Experimental meningococcal infection has been produced quite regularly in the mouse by intraperitoneal inoculation of meningococci suspended in mucin. Of virulent strains approxi-

mately 10 organisms suffice to initiate a lethal infection with invasion of the blood stream. The action of mucin is not clearly understood, but seems to involve interference with the defense mechanism of the host rather than enhancement of the virulence of the micro-organisms themselves. Mice can be protected against infection by preliminary injection of immune serum, which is type specific if monovalent, and they can be spared a fatal outcome if serum is administered in sufficient quantity, even though the infection is quite far advanced.

A study of genital mycosis: H. CLOSE HESSELTINE (introduced by A. J. Carlson). Certain significances of the yeast-like fungi in the female reproductive tract have been demonstrated only recently. The incidence appears to be related partly to the hygienic state. The discussion will give incidences in the pregnant, gynecologic and diabetic patient, include identification problems of the monilia and cryptococci, suggest the influence of available glucose, offer additional evidence that the sporadic oral thrush of the newly born is contracted from the mother, designate avenues now open for therapeutic improvements, and indicate some difficulties in accomplishing cures.

Blood volume changes in eclampsia: WILLIAM J. DIECKMANN (introduced by F. R. Lillie). Changes in blood and plasma volume in eclampsia have been determined by making serial examinations of hemoglobin, hematocrit and serum protein concentration. Determinations of plasma and blood volume have been made with the Congo red method and indicate that in eclampsia there is a very marked concentration of the blood.

A study of the action of some oxytocics, especially ergonovine, on the postpartum uterus: FRED L. ADAIR, M. EDWARD DAVIS and SARAH A. PEARL (introduced by A. J. Carlson). The chemistry, pharmacology and clinical application of a new alkaloid isolated from ergot, ergonovine, which contains most of the desirable oxytocic activity in ergot, was discussed. The various experimental procedures resulting in the isolation of this alkaloid were briefly sketched. A comparison was made of this new oxytocic drug with other oxytocic drugs. A method of studying contractions of the post partum uterus was described and some of the results were presented.

Some relationships between structure and function of organic arsenicals in experimental chemotherapy: ARTHUR L. TATUM (introduced by A. J. Carlson). A large number of organic arsenicals were used to treat laboratory animals, mostly rats, infected with various species of trypanosomes. A result of such a survey revealed the possibility of grouping the drugs into categories according to their effectiveness. The members of one group of arsenicals were effective in curing infections caused by any of several species which are distinctly pathogenic to the host (*T. equiperdum, brucei, rhodesiense*). The members of the other group of arsenicals were effective in curing rats infected with a relatively non-pathogenic species (*T. lewisi*). Those drugs effective on *T. lewisi* were mostly quite ineffective on the pathogenic species, and conversely those drugs effective on the pathogens are ineffective on the non-pathogen. Similar relationships hold true in *in vitro* susceptibility of the organisms toward the drugs. The arsenicals effective on *T. lewisi* possess a carboxyl group, *i.e.*, an acidic group, whereas those drugs effective on the pathogens have alcoholic or amine groups, *i.e.*, basic groups. The differences in ease of cure of the animals infected by different members of the pathogenic series appear to reside in differences in parasite-host relationships. It can scarcely be due to drug-to-parasite relationship, since *in vitro* drug-to-parasite relationship is relatively the same, whereas actual curability of the infected host differs very markedly with different pathogenic species.

The acid-base and energy metabolism of the stomach and pancreas: MARTIN E. HANKE. The metabolism of the stomach and pancreas was studied in dogs by comparative analysis of the venous blood from these organs and arterial blood simultaneously taken. The experimental determinations on the blood were pH, CO_2, O_2 content, O_2 capacity and per cent. water. Comparison of the available base differences in the blood with the acid and alkali in the gastric and pancreatic secretions has shown that in the case of the stomach the two values are equal within experimental error, while in two experiments in the pancreas the latter is about twice the former, and the relation is more variable. The rate of blood flow through the stomach and pancreas was calculated from the difference in the water content of the arterial and venous bloods and the volume rates of secretion of the two juices, on the assumption that the secretion of water in the juices is quantitatively reflected in a decrease in the water content of the corresponding venous blood. Thus a 20-kg dog, with a mucosa weight of 80 gm, a water difference of arterial and gastric venous blood of 0.5 per cent., and a secretion rate of 1.1 cc of gastric juice per minute, has a blood-volume flow of about 60 cc per minute through the stomach. Calculation of the energy metabolism of the actively secreting stomach from the difference in the O_2 content of arterial and gastric venous blood (about 2.4 millimols O_2 per liter of blood) shows a production of 0.14 gm-calorie per minute per gram of mucosa, or 13.5 gram-calories per cc of gastric juice. Calculation of the free energy of formation of the constituents of gastric juice from blood or lymph from the equation $\Delta F = NRT \ln \frac{C \text{ gastric juice}}{C \text{ blood}}$ shows for hydrogen-ion -1.22 gram-calories, for other ions, Na, K, NH_4 and Cl and water, about $+0.10$ gram-calorie, a net total of -1.1 gram-calories per cc of gastric juice. Assuming that there are no other significant sources of energy in gastric-tissue metabolism besides the conventional oxidation of carbohydrates, fats and proteins, it follows that the minimum osmotic work involved in gastric-juice formation is about 9 per cent. of total energy metabolism of the stomach. Similar conclusions have been reached by Teorell (*Skand. Arch. Physiol.*, 66: 279, 1933), using other methods and another species. Similar calculations of data from experiments on the pancreas show a total metabolism of 8.6 g-cal. (an increase over resting metabolism of 5.0 g-cal) for 1 cc of pancreatic juice. The sum of the free energies of formation of the constituents of pancreatic

juice from blood is about 0.5 cal per cc of pancreatic juice. The ratio of these two values is about 6 per cent. (10 per cent. for the increase over the resting metabolism). These "efficiencies" $\frac{\text{free energy}}{\text{total tissue energy}}$ per unit volume of secretion, are much greater in the case of the stomach and pancreas than they are for the kidney, where the quotient is about 1 per cent. (Borsook and Winegarden, *Proc. Nat. Acad. Sci.*, 17: 13, 1931).

Active and blocked embryonic cells—some phases of their physiology: J. H. BODINE (introduced by Carl E. Seashore). Quantitative physiological studies have been made on actively developing and blocked embryonic cells in an attempt to learn further concerning the "block mechanism" normally occurring in certain cells. Rates of oxygen consumption, the effects of carbon monoxide, oxygen lack, cyanide, methylene blue, etc., on the resting and active stages of the embryonic cell have been investigated and an analysis made of the respiratory mechanisms involved.

The formation and fermentation of hexosemonophosphate in muscle: CARL CORI and G. T. CORI (introduced by Joseph Erlanger).

The scientific analysis of piano performance: C. E. SEASHORE. A camera has been devised to measure in adequate detail and graph photographically the characteristics of the player's performance on the piano. The pianist has at his disposal only two variables; namely, time and intensity. Pitch is determined by the instrument; so also is the timbre, except in so far as it can be modified by overholding with key or pedal. The graph of the performance is made on a standard 4" film in the time that it takes to play the selection. Time is measured in .01 sec., and intensity in decibels is measured in terms of the rate of impact of the hammer. This photographic chart is condensed into a musical pattern score.

Stroboscopic studies of the human vocal cords: DR. JOSEPH TIFFIN (introduced by Carl E. Seashore). Stroboscopic moving pictures of the vocal cords in action will be shown. These slow-motion pictures indicate the form of vibration of the vocal cords. Analysis of the cordal movement tends to substantiate the Helmholtz theory of vowel production.

Histological studies of the respiratory portion of mammalian lungs: CLAYTON G. LOOSLI (introduced by C. J. Herrick). A detailed study by various histological methods of the lungs of the monkey, dog, cat, rabbit, rat, guinea-pig, opossum and mouse, killed at various stages of postnatal development, has been made. In these animals a continuous epithelial membrane lining the respiratory portion of the lungs is not found. The alveolar wall is made up essentially of a central stroma of reticular and elastic fibers a[illegible]onnective tissue cells. The meshes of the fibers su[illegible]etwork of blood capillaries which form loops wh[illegible]p the adjacent alveolar spaces. An amorphou[illegible]nce or membrane covers the fibers, cells a[illegible]isolated nucleated cells are scattered over the alveolar walls. Some of the intercapillary spaces in the alveolar walls possess openings or pores which connect adjacent alveoli.

Transmission of successive impulses across synapses: HELEN TREDWAY GRAHAM and RAFAEL LORENTE DE NÓ (introduced by Joseph Erlanger). Normal functioning of the nervous system involves transmission of impulses along a succession of neurones at frequencies ranging from about 5 to 100 per second (intervals of 10 to 200 milliseconds between impulses). Passage of an impulse along the peripherally-placed axons of certain of these neurones—the peripheral nerve fibers—produces long-lasting changes of excitability to electrical stimulation; under certain conditions the fiber after 5 to 10 milliseconds may be more excitable than normally, while after 20 to 100 milliseconds it may be less excitable. It will be observed that these intervals come within the range frequently observed in normal functioning of the nervous system, and it is therefore conceivable that similar changes of excitability, if they occurred under physiological conditions, might play a rôle in the explanation of certain aspects of central nervous activity (facilitation, inhibition, etc). In the physiologically functioning nervous system, however, each neurone is stimulated not by electrical shocks applied to its axon but by the arrival of impulses at the end knobs of the axons of neurones preceding it in the path of transmission. Such stimulation across neurone junctions or synapses may be called synaptic stimulation. The recovery of excitability to this normal synaptic stimulation has been tested by stimulating electrically the neurones ending in synapses with the motoneurones of the trochlear nerve or internal rectus muscle (rabbit eye) from which the impulses were recorded. It has been found that there is no period of increased excitability to such synaptic stimulation, but instead a protracted period of depressed excitability. This depression, which lasts 30 to 50 milliseconds after one impulse, becomes longer and more intense after a succession of impulses (2 to 9 impulses at frequencies of 45 to 200 per second have been found to increase the depression significantly). It appears therefore that certain forms of inhibition in the central nervous system may be explained by changes of excitability to synaptic stimulation and, in particular, that the gradual decrease in excitability with the passage of a train of impulses may account for such phenomena as the dying out of rhythmic activity.

Potentials in the frog's nervous system: R. W. GERARD (introduced by A. J. Carlson).

Some effects of histologic procedure on cells: G. W. BARTELMEZ (introduced by C. J. Herrick).

The secretion of hydrochloric acid in the stomach as revealed by the freezing-drying method: N. D. HOERR (introduced by C. J. Herrick).

Lipocaic, a new pancreas hormone: LESTER R. DRAGSTEDT, JOHN VAN PROHASKA and PAUL B. DONOVAN (introduced by A. J. Carlson). The observations of Fisher (1924) and of Allen, Bowie, Macleod and Robinson (1924) and others that completely depancreatized dogs adequately treated with insulin usually die within two months with

extensive fatty infiltration of the liver was confirmed. The absence of pancreatic juices from the intestine is apparently not the cause of this liver damage, since it was absent in animals with complete pancreatic fistulae and in dogs whose pancreatic ducts had been ligated and the pancreas extensively degenerated. The administration of fresh activated dog pancreatic juice in amounts of from 1,000 to 1,100 cc per day did not prolong the lives of depancreatized dogs nor prevent the development of the typical liver changes. The oral administration of as little as 25 gm of fresh beef pancreas per day was found sufficient to either prevent or to cure the fatty infiltration and to permit survival. Choline is apparently not the substance in pancreas which accounts for this effect, since as much as 700 gm of choline per day were found to be entirely ineffective. An extract was prepared from fresh beef pancreas and found to be effective in curing and preventing the development of fatty infiltration in the liver of depancreatized dogs adequately treated with insulin. This extract is believed to contain a new hormone, for which we have suggested the name "Lipocaic," which plays a rôle in the metabolism of fat. Some properties of this new hormone are described.

The mechanism of the lytic action of bacteriophage: J. BRONFENBRENNER (introduced by Joseph Erlanger).

The antirachitic effect of tartrate and citrate: BENGT HAMILTON and M. DEWAR (introduced by H. G. Wells). On the basis of certain theoretical considerations it was thought possible that the oral administration of tartrate or citrate would prevent the development of rickets in rats on a rachitogenic diet. This prediction proved to be true, the salts proving to have a preventive effect as marked as that of cod liver oil. It was also shown that fully developed rickets could be effectively healed by the addition of these salts to the rachitic diet, although the healing effect was not, perhaps, as marked as that of vitamin D. The cause of this antirachitic action of tartrate and citrate is not quite clear.

Termite nests—a study of the phylogeny of behavior: A. E. EMERSON (introduced by C. M. Child). Termite nests may be used as examples of behavior evolution because they are morphological indications of behavior patterns, they express the behavior of a population, the patterns are hereditary, there is a natural control over any Lamarckian influence, evolutionary sequences are available, adaptive modifications may be demonstrated, and coordination mechanisms may be partially analyzed. Wood-eating roaches, similar to the hypothetical ancestor of the termites, excavate galleries in wood but make no constructions. The Kalotermitidae excavate wood and construct partitions indicating responses to humidity and mechanical or chemical factors. The Mastotermitidae exhibit a quantitative advance in nest construction compared to the Kalotermitidae. The Hodotermitidae show a further advance with subterranean nests, elaborate carton construction and food storage. The Rhinotermitidae have separately evolved subterranean adjustment and in some species show building activities in response to social factors as well as physical factors. Excavated subterranean nests of the Termitidae exhibit the influence of mechanical and spatial factors. Materials may be dirt, wood or excrement, cemented by saliva or excretions. Structures consist of covered tunnels, roads, rain-shedding projections and ridges, nests of characteristic size and differentiation, ventilation pores in the walls, stored food and fungus gardens. Sterile workers and nymphs of sterile soldiers and workers construct the nests in the Rhinotermitidae and Termitidae. The ecological functions of the nest are the control of temperature, the control of humidity, the protection from predators and harmful fungi—all enabling the termites to live in otherwise uninhabitable niches. The nesting site may be selected partly or wholly by the colonizing pair, but often is selected by the workers followed by a colony migration. Height of the nest from the ground may be fairly characteristic of the species. Different species within a genus may show great divergence in nesting behavior. Species of the genus *Amitermes* have subterranean nests, mound nests, arboreal nests, nests oriented with reference to the sun and rain-shedding constructions. Convergent evolution of rain-shedding constructions has occurred in the Amitermitinae, Termitinae and Nasutitermitinae. "Intelligence" of termites reported in the literature is usually strongly anthropomorphic. Behavior evolution should be correlated with morphological evidences of evolution. Degenerative evolution of behavior patterns may be explained by modern genetic theory.

An evolutionary analysis of insular and continental species: ALFRED C. KINSEY (introduced by C. M. Child). Insular and continental forms so differ in their constitution and behavior that evolutionary theories adequate to the one type of species are not all applicable to the other. In an attempt to evaluate the evolutionary data from the laboratory genetics, the gall wasp family Cynipidae is being used as the basis of an intensive study of species as they actually occur in nature. Among the more than 300 species so far studied, most of the forms which match the current concepts of continental species are located in the eastern half of the United States. There the uniform topography offers few geographic factors to isolate species, and even distance may fail as a factor because of the recent interchanges of faunas and floras consequent on the Pleistocene glaciations. These species all have large ranges, and they show considerable intra-specific variation, local subdivisions of each population, and extensive intergradation from one species to the next. In the western half of the United States, and throughout Mexico and Guatemala, the highly varied topography and multiplicity of the oak hosts of these insects provide isolating factors as effective as the waters surrounding oceanic islands. The essentially insular species occurring there have relatively small ranges, often show a minimum of individual variation (although in some cases the variation is great), rarely develop local variations within the populations, and almost never develop in[illegible]rgrades between species. The Darwinian concept [illegible]mulative variation seems inapplicable, whi[illegible]atory data on mutation seem sufficient ex[illegible]the origin of most of these species. T[illegible]ve been such an early isolation of the n[illegible]peripheries of

the ranges of the parental species that gene frequencies were soon reduced to equilibrium. While the interspecific gradation between continental species is usually taken to substantiate Darwinian concepts of the multiplication of species through gradual transitions, the intermediate groups seem more exactly analyzed as hybrids between what were originally isolated stocks. Thus the evolutionary pattern laid down by insular species may be taken as basic to the interpretation of continental species. In continental species, however, the chance that interspecific hybridization may give rise to a new species is much greater than among insular species.

Meteorological environment and organic differentiation: W. F. PETERSEN (introduced by F. R. Lillie). In the material presented, confirmation of the Hippocratic suggestion of the rôle of the meteorological environment during the early development of the embryo (paratypic differentiation) is sought. It is assumed that with periods of greater meteorological turbulence the more profound autonomic disturbances of the maternal organism (uterine vascularization and tonus) will disturb the uniformity of environmental conditions for the rapidly developing embryo, with the possibility of optimal stimulation on the one hand as well as injury on the other. An examination of the seasonal conception distribution, of still births, of birth rhythm and premature delivery is first presented. There follows evidence for mental differentiation, including unusual intelligence, feeble-mindedness, the criminal type, the criminal insane and the insane. A study is made of adult habitus with relation to the period of conception, as well as a study of the conception periods of groups who have died from various diseases, including tuberculosis, endocrine disturbances, leukemia, diabetes, etc. A discussion of the possible mechanisms involved and of the significance for racial differentiation.

The laws governing the distribution of bone marrow in the extremities in mammals: CHARLES HUGGINS (introduced by F. R. Lillie). In newborn mammals all bone marrow is red. Soon a peripheral regression of red marrow takes place, and the adult state consists of a central accumulation of red marrow with a peripheral yellow marrow. A thermal decrement has been found in the peripheral bone marrow as compared with the central areas. Elevation of temperature of the outlying regions causes a retention of red marrow or a regression of yellow marrow with replacement by blood-forming tissue.

Establishment of diurnal temperature curve in the child: N. KLEITMAN and S. TITELBAUM (introduced by A. J. Carlson).

A study of certain fatigue symptoms in mental work: A. G. BILLS (introduced by C. J. Herrick). The proposed report brings together the main results of a program of research designed to get at the basic principles of mental fatigue, by analyzing the behavior changes resulti‑ from continuous mental work. The discovery ‑ ‑ ‑nrecognized fatigue symptom, the "block" ‑ccurring more or less periodically at ‑ring work, led to studies of the following special problems: (1) The progressive incr‑ in length and frequency of blocks with prolonged wo‑ (2) the decrease resulting from practice in the tas‑ (3) the effect of kind of task and rate of work; (4) the relation of blocks to error causation; (5) a comparison of blocking in manual and in vocal performances; (6) the exaggeration of the phenomenon in the manual (as well as vocal) performance of stutterers; (7) the relation of the block rhythm to various rhythmic physiological activities, such as breathing; and (8) an investigation of the relation of blocking to nervous metabolism, by noting the effect of systematically varying the oxygen supply of persons engaged in mental work, and the effect of breathing pure oxygen on the performance of persons already fatigued from an hour of mental work. The results indicate that the block is the most sensitive objective fatigue symptom; that it probably serves a function similar to refractory phase, in giving frequent short rests to the reacting mechanisms which prevent excessive exhaustion; and that it is independent of any specific organic rhythm. It occurs in manual responses as well as vocal; is exaggerated in stutterers, and in hesitant speakers; and is a major factor in error causation. It is exaggerated in proportion to the homogeneity and complexity of the task. It is exaggerated under conditions of anoxemia, in inverse proportion to the percentages of oxygen used and the duration of the work period. The excessive blocking present in fatigued workers is apparently reduced by breathing pure oxygen. These last findings suggest a close relation of blocking to the oxygen metabolism of either the nervous or sensory motor mechanisms.

Contrasts in the genetic effects of ultra-violet radiation and x-rays: L. J. STADLER and G. F. SPRAGUE (introduced by Sewall Wright). Ultra-violet radiation applied to mature pollen of maize induces mutation and deficiency, but unlike x-ray treatment it has little or no effect on the frequency of translocation. The endosperm deficiencies induced by UV include a larger proportion of fractionals, and the relative frequency of loss of specific marker genes differs distinctly from that found under x-ray treatment.[1] Since the frequency of deficiency was lower under the UV doses used than under the x-ray doses commonly applied, it is possible that the difference in effect on translocation is incidental to dosage. If translocations result from chromosome breakage followe‑ by reattachment of broken ends in new combinations, translocation can occur only in cells with two or m‑e breaks. ‑he rarity of translocation following UV treatment ma‑ ‑en be due to the smaller number of breaks produced ‑ ‑ dose applied. A further trial was made, co‑ ‑mal dose of UV wi‑ a rather low dose ‑ wer‑ mately equal in for the endospe‑ ducing about one entire endosperm fractionals as ‑ translocation ‑ direct cytolog‑

[1] *Proc. Na‑*

ts of the F_1 progeny. Only one translocation was nd in the UV progeny, while 44 per cent. of the ants of the x-ray progeny showed translocations, several of them two or more independent translocations. The frequencies of plants with segregating defective pollen were 14 per cent. and 77 per cent., respectively.

The reality of neurofibrils in the living ganglion cell and nerve fiber: PAUL WEISS (introduced by C. J. Herrick). Photographs were presented demonstrating the existence of neurofibrils as discrete filaments, both in the cell body and the axone of living ganglionic cells of chick embryos grown in tissue culture but otherwise untreated. The experiments (done with the assistance of Mr. H. Wang) consisted of explanting embryonic spinal ganglia into blood plasma under provisions permitting direct microscopic observation. The gradual appearance in the healthily growing and differentiating cells of neurofibrils was observed in the course of prolonged cultivation up to two weeks. These observations seem to end the old argument of the reality versus artifact nature of neurofibrils in the living undisturbed cell, specifically in regard to warm-blooded vertebrates.

The physiological basis of heterosis: R. A. BRINK (introduced by Sewall Wright). Cross-fertilization in *Medicago sativa*, using an unrelated strain as the pollen parent, increases the proportion of functional seeds formed several fold, as compared with self-fertilization under the same conditions. The disparity results from a much lower incidence of abortion during development in the case of the hybrid embryos. The superior ability of the latter to continue growth to maturity may be considered a manifestation of heterosis. It is a well-recognized fact that growth in certain regions of the plant tends to suppress it in many other potential centers of similar activity. Immature embryos are subject to the conditions imposed by this growth-regulating mechanism and continue development or abort according to the reciprocal relation established between them and their environment in the host plant. The increased capacity of hybrid as compared with inbred embryos in Medicago to complete development may be accounted for on the assumption that the primary effect of outcrossing on the physiology of the resulting zygote is to shift the balanse in the growth-regulating mechanism in favor of the forward processes and against the retarding influences. The natu e of the growth-regulating mechanism is obscure, but some facts concerning it are available which en one to visualize how such a shift might be effecte here is much evidence suggesting that het neral may rest upon physiological basis

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n between the
gy of the oxidizable substance, a knowledge of these free energies is essential for the understanding of the mechanism of biological oxidations. The free energy (as determined by measuring the oxidation-reduction potential) of hemin and of a number of hemochromogens (cyanide, nicotine, pyridine, α-picoline, pilocarpine, histidine) has been studied. It has been found that the oxidation reduction potential of hemin becomes *more positive on its conversion* to hemochromogen, the potential varying with the nature of the nitrogenous compound attached to hemin. Thus at pH 9.50, the E'_0 of hemin is –0.235 volt; that of cyanide-hemochromogen is –0.182 volt; of pilocarpine-hemochromogen, –0.156 volt; of histidine-hemochromogen, –0.138 volt; of α-picoline-hemochromogen, –0.022 volt; of pyridine-hemochromogen, +0.017 volt; of nicotine-hemochromogen, +0.053 volt. The ratio $\frac{\Delta E'_0}{\Delta \mathrm{pH}}$ of hemin changes with a slope of –0.06 volt per pH unit from pH 7 to 9.2, and with a slope of 0.09 from pH 9.2 to 12. The E'_0 of cyanide-hemochromogen remains constant. The E'_0 of the other hemochromogens changes with a slope of about 0.06 volt per pH unit. Pyridine and nicotine-hemochromogens, at pH 11, give titration curves similar to that of systems with 2-electron transfer, due possibly to polymerization. Hemin and the other hemochromogens pass from the oxidized to the reduced state with a transfer of one electron. The fact that the potential of hemin can be changed to varied levels of energy by the addition of nitrogenous compounds explains why catalysts containing hemin as the active nucleus, to which are attached a variety of nitrogenous compounds, oxidize selectively a considerable number of oxidizable substances of different free energies.

Variation in Ustilago zeae: E. C. STAKMAN. *Ustilago zeae*, the fungus that causes corn smut, comprises an indefinite number of strains or lines. This fungus is especially suitable for studies of heritable variations, because single unicellular, unisexual individuals can be isolated and propagated vegetatively on nutrient media in the laboratory, thus giving rise to unisexual lines. Barring mutation, all individuals in any one of these lines are then alike in their heritable properties, as has been shown by extensive studies. But innumerable new lines can be produced by hybridization between lines and by mutation within lines. Even from the progeny of two unicellular individuals of opposite sex that were crossed about three years ago by the writer and his associates, hundreds of lines have arisen as the result of segregation and mutation in laboratory and greenhouse cultures. These lines differ from each other in one or more of the following characters: type of growth; color, size and topography of colonies on artificial media; sex and parasitism; and tendency to mutate. Several hundred mutant lines have been isolated and studied; some are conspicuously different from each other, and others differ in almost imperceptible but distinctive characters. Factors for the new mutant characters are inherited when mutant lines are c d with lines of opposite sex. The tendency to due to heritable factors and differ lines. When crosses were made be

denser lots, on the average, were
first cleavage, 14–20 per cent. ahead
and 10 per cent. ahead at third
d with accompanying sparse lots.
ical probabilities are: $P = < 0.0001$,
nd $P = 0.0002$. We know that some-
can be produced by the presence of
tances, as in other and better ana-
ss protection; great care was taken to
ination in this work. Analysis of the
lved has given only negative results to
included increasing artificially the car-
t of sea water to various slight degrees,
-conditioned sea water which had been
al different methods. Hence while the
al, the underlying processes are still

ives of the neural folds in amphibian
nt cells, spinal ganglia and Rohon-Beard
P. DUSHANE (introduced by C. M. Child).
volving bilateral excision and transplanta-
nk neural folds indicate that the following
ts are derived from the folds: (1) pigment
phores, guanophores and melanophores) of
and the deeper structures (pericardium,
(2) spinal ganglion cells; (3) Rohon-Beard
glion cells. Such embryos later show motor
tactile stimuli applied to head or tail, but
o trunk stimulation. Rohon-Beard cells are
he insensitive region and present in the
(head and tail). Despite the fact that
cells, which normally form the sensory
cord, are absent from the trunk, sen-
from the tail headward through this
ble, as Coghill has suggested in a
n, that the Rohon-Beard cell axons
o the anterior part of the spinal
scending tract. Coghill's prepa-
therto unsuspected length. One
owed through six segments of
that the Rohon-Beard cells
ave a common primordium
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(introduced by F. R. Lillie). This represents one of a study of hereditary and environmental fact sponsible for twin differences and, by inferenc human beings in general. The work has been don collaboration with two colleagues, F. N. Freeman a Karl Holzinger. A monograph on the whole study is r in press. In this particular study twenty pairs of i tical twins separated in infancy and reared apart u differing environments were used. Many physical, in lectual and temperamental differences were determined direct measurements and by tests. Full data on the li histories of the twin pairs were then rated by five judg independently, differences being rated on a scale from to 10 points, for education, social and physical-healt separately. The agreement was over 90 per cent. in al three categories and was considered as highly satisfac tory. Then coefficients of correlation were determined for each of the measured differences and the various rated differences in environment. The majority of the coefficients were statistically non-significant, but a few were high and statistically valid. The most striking correlation was between amount of educational experience and amount of difference in scores of several intelligence tests. The least correlation existed between differences in social environment and differences in scores on several temperament-emotion tests. Differences in physical-health environment were strongly correlated with differences in weight, but not at all with height, head form and other physical differences. By determining the degree of correlation between measured differences in twins and the various environmental differences, it was possible to state approximately the shares of the different environmental factors in determining the observed differences in the whole set of twins.

The utilization of organic and inorganic iron in early infancy: HELEN OLDHAM and F. W. SCHLUTZ (introduced by A. J. Carlson). The iron retention of a normal infant was studied at three different levels of total iron intake. Each level was fed with varying proportions of inorganic iron. The organic iron of the diet appeared to be utilized as well as the inorganic iron.

Histology of the bone marrow in cobalt polycythemia: KATSUJI KATO (introduced by C. J. Herrick). In young rats first made anemic on an exclusive goat's milk diet, polycythemia was produced by administration of iron and cobalt. Sections made from the mid-femur shows a marked hyperplasia of all the hemopoietic elements, especially of the myeloid series. The hyperplasia of the erythron consists mostly of normoblasts, although scattered throughout the marrow are also found many clusters of more primitive erythroblasts. The megakaryocytes also showed definite quantitative increase. The fat cells are reduced in number.

The influence of ten-
sure:

ines, some of the resulting segregates were very le, others moderately so, and still others were con- , but by crossing the most mutable lines with each er for several generations material has been obtained which all segregates are extremely mutable.

eed-cone development in Sequoia gigantea: J. T. CHHOLZ (introduced by William Trelease). For *quoia gigantea*, the information concerning seed-cone oduction has been very fragmentary. This information essential as a first step in a study of the embryology of his species. The cones are evergreen and persistent for many years after the morphological development of the embryo is completed within the seed. Some measurements have been made on the diameters of the leaders, the seed-cone-bearing branches, vegetative branches and pollen-cone branches. New methods have been worked out by which the dates of origin, pollination and development of the cones may be determined even after many years so that most of the cones and their seeds may be dated with a fair degree of accuracy. Seed cones require three years in their formation. They are formed at the tips of branches during the summer of a given season, pass the first winter within a bud and are pollinated during April of the following spring. During the summer of the same season, the cones enlarge very greatly, becoming full grown, hard and woody in August. Fertilization takes place during the last week in August. The embryos begin to develop, but pass the winter in a very immature condition and require still another season for their growth, so that they are morphologically developed only by the end of the second year following pollination or at the end of the third year after the formation of the cone primordium at the tip of the stem. The embryo is very small during the first month after fertilization and undergoes cleavage polyembryony. The smallest stage of the embryo observed thus far, a 2-celled stage after cleavage of the zygote, was 20,000 cubic microns. Thus, in the big tree which may eventually reach a volume of 1,640 cubic meters (estimated for the General Grant tree), the organism enlarges 82×10^{15}-fold. The mature specimen of *Sequoia gigantea* is as much larger than its embryo as the earth is larger than a building similar in size to the dome of the Adler Planetarium.

Reaction gradients and pigmentation thresholds in the feather germ: RICHARD M. FRAPS (introduced by C. M. Child). Lillie and Juhn published in 1932 a detailed account of the order of localization, extension and reversion of patterns induced in breast and saddle feathers of the Brown Leghorn capon by injection of hormones (female hormone and thyroxin). On the basis of these and other data they concluded that the feather germ is bject to growth-rate distributions which determine or- ... to the hormones employed. The "high" ... the ventral limit of which

orders of pigmentation which are ... the reverse of those described by Lill... lished data of Mary Juhn). On the ... forces tending to effect alternati... tions are *differential functions* ... gradient, these orders of pigment... accounted for without change in dir... dorsal (or apico-basal) gradient post... Juhn. Alternative pigmentation thres... this view, functions of the relation be... differential gradient functions. The ... satisfactorily for experimental results Brown Leghorn, and may possibly be ... pretation of phenotypic pigmentation ... in the plumage of this breed.

Spectrographic analysis of pure sam... and nuclei from liver cells: GORDON H. S... by Joseph Erlanger).

The conjugated form of male sex-hor... urine: DUREY H. PETERSON, T. F. GALLI... KOCH (introduced by J. Stieglitz). Here... of male-hormone activity as extracted from... without boiling and with boiling for two h... was practically the same. We now find t... acidified urine is boiled for fifteen minute... male hormone is increased by approximatel... over the no-boiling or the two or more hour... ess. This is true for men's and women'... results suggest that a conjugated form of ... is liberated by acid hydrolysis and the... quently destroyed by boiling with acid.

Some effects of numbers present o... cleavage in Arbacia: W. C. ALLEE ... (introduced by C. M. Child). Oth... under the conditions tested, *Arba...* if in moderately dense groups ... few present in the same volume too many eggs are piled upon e... ture, evaporation and other pe... these relations held when te... from drops of 10 cu mm water. In the latter cas... crowding was obtained ... 10,000 eggs present, wh... lots of a few tens of ... ployed: In one, the ... found for living eg... In approximately ... kinds, the mean ti... faster in the dens... this increased t... tical significanc... $P = 0.05$ is eq... The smaller ... significance.

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MORPHOLOGY AS A DYNAMIC SCIENCE[1]

By Professor EDMUND W. SINNOTT
BARNARD COLLEGE, COLUMBIA UNIVERSITY

WHEN a science has developed to the level where it can recognize the fundamental problems which confront it, it may be said to have passed from youth to maturity. Long ago the physical sciences were able thus to formulate their objectives, and they have made enviable progress in attaining them. Biology, on the other hand, throughout its history has moved from one major interest to another and has never seemed able to distinguish its fundamental problems from a host of minor ones, or indeed to determine whether or not there exist any strictly biological problems at all. Not many generations ago the naming and classification of the host of plant and animal species was regarded as the chief task of the biologist. This naive attitude was altered by an acceptance of the tremendous fact of evolution, which seemed to make obvious that the central problem of both botany and zoology was to write the entire phylogenetic history of the organic world, a task which commanded the allegiance of the majority of biologists for half a century.

As time went on, however, it came to be realized that the ultimate secret of a living organism will never emerge from the records of its ancestry, no matter how completely these may be deciphered. Physiology is evidently nearer than phylogeny to the ultimate problem. Stimulated by the great advances which the physical sciences had made, the attack through physiology began about a generation ago to attract many new workers and gave every promise of substantial progress. The years have found this promise amply fulfilled in our success in plotting the flow of physical and chemical change of which an organism is the seat, but the results of physiological research have tended

[1] Address of the retiring vice-president and chairman of the Section on Botanical Sciences, American Association for the Advancement of Science, Atlantic City, December 29, 1936.

to emphasize the complexity rather than the simplicity of protoplasm and have entirely failed as yet to solve the elusive problem of what an organism really is. A similar frustration has attended still another line of attack, through the science of genetics. Ever since the rediscovery of the Mendelian principles of heredity, this discipline has been enthusiastically pursued by many students who felt that here, at last, something fundamental in biology had made its appearance. The truly sensational development of the chromosome theory, with its demonstration that the genes are definite physical entities occupying constant positions in the chromosomes, has justified this early enthusiasm; but with their first major objective attained, geneticists are coming to realize that their really basic problem is not the location and transmission of genes but the mechanism by which these control the development of an organism, a question about which our ignorance is almost complete.

Although these attacks on so many widely separated fronts have not yet pierced to the center of the problem of life, they have served to clear away many obstructions and to open the road toward our chief goal, which is now just beginning to appear. Biologists are at present in the position of the early explorers of the mighty mass of the Himalayas. They have pushed in from various directions, seeking the best and most practicable routes. Many of the foothills have been climbed and a few important peaks conquered. The increasing difficulties of the terrain, once underestimated, are now recognized. Still more important, the existence of a central dominating range seems to have been established and glimpses have been gained of the very highest peak itself. The main objective of our labors is at last becoming more clearly defined.

To formulate with anything like assurance a problem which is central and fundamental for all biology, the Mount Everest of our scientific exploration, may still seem to many an act of faith rather than of sight; but within the last few decades, and recently in increasing numbers, many biologists, as well as thinkers who have approached biological problems through the physical sciences and through philosophy, are agreed in emphasizing one particular problem, one general phenomenon of life, as of primary and dominant significance. This may be stated in a word as the problem of *organization*. Living things are well termed *organisms*. The activities of their manifold structures are so integrated and coordinated that a successfully functioning whole individual develops. As to how this is accomplished very little is known. The advances of biological science have been chiefly in quite the other direction, in breaking down the organism into its constituent organs, tissues and cells, into chromosomes and genes, into protein molecules and cellulose chains, into potential differences, axial gradients and morphogenetic fields. But analysis alone, however detailed it may ultimately be made, can never lead to a complete understanding of an organism. Synthesis also is required. What it is that coordinates these various parts and processes so that an organism rather than a chaos results, what synthetic factors there may be which knit the organism together into a functioning unit, are extraordinarily difficult problems. They do not yield readily to the direct and obvious methods of attack which have usually been employed in biology and they tend to become involved in philosophical as well as strictly biological difficulties. It is probably safe to say, however, that the majority of botanists and zoologists to-day would admit that this problem of organization is indeed their ultimate and central concern; and that if the biological sciences have any problem peculiar to themselves and differentiating them from the physical sciences, this is the one.

My purpose in making such an excursion as this into biological fundamentals is to defend the thesis that the solution of our basic problem can be approached more simply and directly through the study of *form* than by any other means; and that morphology, far from being the hopelessly static discipline which some would have us believe, therefore touches so intimately the central problem of biology that it may still be described by Darwin's words, in a famous passage of the "Origin," as the "very soul" of natural history. Let us examine the evidence for this contention.

The correlative mechanisms by which an integrated living individual is maintained are, of course, physiological in character and are doubtless ultimately resolvable into physical and chemical processes; but their investigation from the point of view of physiology alone is usually beset by such difficulties that substantial progress on this front must wait until the necessary experimental technique is much more highly perfected than it is to-day. The coordinating and integrating capacity of protoplasm, however, is displayed not only in those correlations of function which so excite our amazement but also in the more familiar and no less remarkable correlations of growth, operative during the process of development and resulting in the production of those specific and constant shapes of organ and body which are so characteristic of living things. A fertilized egg divides this way and that in such a precise manner that an embryo with two cotyledons, a plumule and a hypocotyl, definite and specific in form, are produced. From a tiny mass of undifferentiated cells at a growing point are developed the primordia of organ after organ in a perfectly regular fashion, and each follows in its enlargement a definite

pattern of growth. In all such cases there is manifest in the clearest fashion that coordinating control of which I have spoken. Form is merely the outward and visible expression, fixed in material shape, of that inner organized equilibrium which we are seeking to understand.

A study of organization as thus expressed in form has the very great advantage that it deals with a visible and stable product, readily observed throughout its entire period of development and measurable with relative ease. The dynamic system which underlies this development of form, on the contrary, consists of a series of physical and chemical processes so complex and changing that they are much more difficult to recognize and to measure. Their product, to be sure, is less immediate to our problem than the process which forms it, but product can often be investigated where process can not. We should first examine these more tangible aspects of the phenomenon of organization, using them as a means of penetrating to the more obscure vital activities by which they are underlain.

If it be admitted that our basic problem can thus be approached most simply and directly through the door of morphology, then an investigation of the factors which determine organic form assumes a major place in biological science. That this importance is coming to be generally recognized is evident in the diversity of directions from which developmental problems in plants and animals are now being attacked. Physiology has always regarded correlative development as an integral part of its domain, but in recent years this subject has assumed a steadily growing importance, as witness the intensive researches on hormones, organizers, metabolic gradients and morphogenetic fields. Genetics is now increasingly concerned with an attempt to discover how genes control development and thus produce the traits by which they are recognized. Ecological attack upon the problem of changes in form through environmental factors has been intensified by discoveries in various fields. Even physicists and chemists have been intrigued by developmental problems and have made important contributions toward their solution. This field of investigation—call it experimental morphology, causal morphology or morphogenesis—is thus drawing to itself some of the best thought and skill of the biological sciences and promises soon to assume a position of major interest and activity.

In this diversified attack upon the problem of the causes of the coordinated developmental processes which result in the production of organic form, only a relatively minor part, strangely enough, has been played by those biologists who might have been expected to be more interested in it than any one else—the morphologists themselves. With important exceptions, those botanists and zoologists whose primary concern has been with the form and structure of living things have contented themselves with the static and descriptive aspects of their science rather than with its dynamic and developmental side. The reason for this one-sided emphasis in morphology is evidently a historical one. The form of organisms has always fascinated biologists. Its constancy in each species, its almost infinite diversity and the existence of underlying similarities in form between groups of organisms have persistently demanded an explanation. Long delayed though this was, it seemed at last to have been completely and triumphantly provided by the theory of evolution. What could be more obvious than that all this diversity of form was the result of evolutionary divergence? What more certain than that structural homology was due to common ancestry? Under the tremendous impact of this new idea it was inevitable that students of organic form should regard as their primary task a careful description of the external and internal structure of plants and animals so that by diligent comparison of a wide range of types the evolutionary history of the organic world could be reconstructed. In the period of its greatest expansion morphology thus became preoccupied with phylogeny to the exclusion of almost everything else, and this primary interest has largely persisted to the present time.

Such preoccupation is to be explained not only by the importance of the phylogenetic task itself but by the inherent attractiveness of such problems as these. The piecing together of evidence from many sources, the reconstruction of divergent lines of evolutionary descent within a group of organisms, and the recognition of homologies between apparently diverse structures excites the same sort of interest as does a jig-saw puzzle or a detective story and appeals to the primitive human urge to bring order out of chaos. No one who has ever tried to solve a phylogenetic problem can fail to recognize the peculiar fascination which it possesses for its votaries.

With all these influences at work it is therefore not surprising that the purely descriptive and historical phases of their work have attracted the chief attention of most of those whose major interest is with the study of organic form. The results of this study have been of very great significance in the development of biology, and the writer has no wish to disparage them in any way or to belittle the contribution which they have made and will continue to make toward our understanding of living things. Nevertheless, if the argument developed in the present paper is sound, the dynamic aspect of the problem of form is of far greater ultimate significance than its descriptive side alone. Morphology should concern itself with causes

as well as with results, and should not abandon this most promising, though most difficult, part of its territory to be explored by physiology, genetics, biochemistry and other sister sciences whose main interests lie elsewhere. If it is at this spot where the chief treasure is hidden, the cooperation of all is surely to be welcomed in bringing it to light, but those who first staked out a claim here should lead in the search and be sinking the deepest shaft.

To all this it may be objected that names are unimportant; that whether those who attack the dynamic aspect of form call themselves morphologists or cytologists or biophysicists is quite immaterial, for no morphological caste or guild can claim precedence for itself here. Of course this is true, but as a practical matter it should not be forgotten that the material which presents itself to the student of morphogenesis is complex and requires a rather special knowledge on the part of the investigator if he is to be safe from error and waste of effort. An outsider is notoriously prone to make absurd mistakes if he works in a field which is not his own by experience and training, and nowhere is this more true than in problems involving the data of morphology. One who is well trained in this field has a very real advantage in morphogenetic studies.

But the morphologist may object again that by temperament and training he is unfit to undertake problems involving the dynamic side of his subject, since these require an approach through experiment and the methods of the physical sciences, with which he is often unfamiliar and unsympathetic. As he can not thus be of real service here, he may ask, why not leave him in the ivory tower of his phylogenies and his life histories and turn over to the physiologists and their allies, fortified by a little better morphological training, the whole troublesome task of determining the causes of form?

Such a defeatist attitude, it seems to me, is based on the erroneous assumption, often made by both morphologists and non-morphologists, that the only way to attack the problems of morphogenesis is by experiment, involving almost immediately the techniques of the physical sciences. No one, of course, questions the great importance of the experimental method or the desirability of resolving as promptly as possible the problems of development into the simpler ones of physics and chemistry; but as a matter of sober fact, most of these problems are not yet in a position where they can profitably be attacked in this manner at all. Before we can intelligently set up experiments to determine the integrating and coördinating growth processes which control development and produce specific forms, we must first obtain precise descriptive information as to *exactly how development proceeds.* Furthermore, in most cases where as the result of experiment a difference of form or structure has been produced, it is of the utmost importance to analyze in morphological terms the exact changes involved. Long before normal development, or experimentally produced changes in it, can be expressed in physical or chemical terms, they must be expressed in morphological terms. The first step backward from the visible end result of a developmental process toward the ultimate inducing cause—be this gene, hormone or radiation—must be a more refined *description* of this result and of the visible steps which lead up to it. This is obviously a job for the morphologist. An enormous amount of spade-work of this sort needs to be done in almost every morphogenetic problem, for our knowledge of the exact steps in the development of most organs, in terms of cells, tissues and precise visible changes, is still shockingly meager. In our haste to interpret results in ultimate terms we have too often failed to find out exactly what these results really are. The chief service which the descriptive morphologist can do for the experimental morphologist is to provide just this sort of information. No one can do it as well as he. I believe that there is no other task confronting him which is so important.

But it is not only a descriptive knowledge of development as expressed in words that the student of morphogenesis requires. In one important particular the morphologist must change his usual technique if he is to make it serve the dynamic aspect of his science: *he must present his results in quantitative terms.* Only thus can they yield themselves to precise analysis and to interpretation in terms of the physical sciences, and only thus can they serve as a means for the discovery of new facts and relationships. To the scalpel and forceps, the microtome and the microscope, the morphologist must add the ruler and the scale as part of his equipment if he is to make his data serviceable to morphogenetic science.

An example or two will illustrate the essential part which quantitatively descriptive morphology can play in developmental and morphogenetic problems.

The coleoptile of the oat has long been an important organ for the study of the effects of plant hormones on development. Its growth and angle of bending have been measured in many experiments, but not until recently was its developmental history carefully studied in terms of internal structure. Avery and Burkholder have now determined the distribution and duration of cell division within it and have measured the changes in cell size in all its tissues and in all stages from seed germination until it reaches maximum growth. This was a morphological task, but it has provided the necessary basis for any thorough-going analysis of the precise effects of hormones on the development of this organ.

In my own laboratory we have been studying the

genetic basis of shape differences in the fruits of the Cucurbitaceae. These characters can be described by the patterns and shape indices of the mature fruits, but such tell only part of the story. It is essential to learn the developmental history of each type if we are to find what the genes actually control here. When length and width are measured at successive stages from ovary primordium to ripe fruit it is found that they grow at different rates, so that the fruit changes in shape somewhat during its development. The relative growth rate is consistently different in different races. In the Hercules club, length grows faster than width, so that the fruit becomes progressively more elongate. In the bottle gourd, on the other hand, width grows faster than length. Within a given race, however, this relationship is so unvarying that it may be expressed by a simple value or constant and thus used to describe very precisely the most important aspect of a fruit-shape difference. This constant relative growth rate segregates in inheritance and seems to be what the genes governing shape primarily control. It thus constitutes an important step into that unknown territory between the gene and the visible shape which this determines. The existence of such a constant relationship as this in the midst of developmental diversity and change could not have been recognized without a careful descriptive study of the entire history of the growing fruit, expressing its results not only in words but in measurements.

Such examples could be multiplied almost indefinitely, and from work with animals as well as with plants. The whole domain of developmental morphology, illuminated by the ideas and view-point of morphogenetic research and attacked by quantitative as well as qualitative methods thus offers a wide field for fruitful investigation. Let no one disparage such studies as "merely descriptive." Description must precede explanation, and in the combined attack on the problem of organization the morphologist should be a leader, not a follower. His is the task of the pioneer entering a wilderness of facts, which must be explored and cleared up before those who follow in his steps can practice their arts of greater refinement and precision.

For the welfare of biology as a whole, therefore, it is my plea that those who have been trained in the rigorous disciplines of morphology may turn in increasing numbers to the more dynamic aspects of their subject. Especially let us hope that those younger botanists and zoologists who choose to devote themselves to the problems of organic form may realize that these can not be set apart as a static compartment of biological thought but must touch and illuminate the whole. May they help to resolve for us this fundamental paradox: that protoplasm, itself liquid, formless and flowing, inevitably builds those formed and coordinated structures of cell, organ and body in which it is housed. If dynamic morphology can come to the center of this problem, it will have brought us close to the ultimate secret of life itself.

OBITUARY

STANLEY R. BENEDICT

THE death of Stanley Rossiter Benedict on the night of December 21 was a grievous shock to his friends and colleagues. He was only fifty-two years of age, and while he had suffered some physical disabilities in recent years he seemed to his friends to be in the prime of useful life until about a week before his untimely end.

Benedict's claims to distinction are of a very substantial order. As professor of biological chemistry in the Cornell University Medical College, he was a teacher of wide repute, who added much to the dignity of a young and growing department, where many workers of both sexes obtained not only knowledge but standards of scientific integrity which served them well in later life. His collaborators make up a lengthy list, and in addition to the younger workers his long association with Emil Osterberg, who survives him, is happily commemorated in many joint publications. Like all generous men Benedict was only intensely pleased with the successes that came to his former pupils. His early training had been in part at New Haven, and in most respects he was a true disciple of the Chittenden-Mendel tradition of physiological or metabolic chemistry. He possessed in addition masterly skill in analytical chemistry, a sound appreciation of physiology and considerable knowledge and ready understanding of the problems of structure that organic chemistry was presenting to the developing science of biochemistry. His attitude to the purely physical side of his subject may probably be described as receptive and sympathetic rather than enthusiastic.

His skill as an analyst can only be compared with that of Folin, with whom it must be confessed he was frequently in spirited argument, which only served to cement the underlying friendship of the two men, who really had much in common. Benedict's researches on the estimation of sugars, creatine, creatinine, purines, uric acid, phenols, sulfur, glutathione, ergothioneine and many other substances, by both macro and micro methods have become part of every biochemist's training. But he was not content with analysis for its own

sake and not infrequently made important discoveries of new substances whose presence had been indicated by the use of his precise analytical methods. Thus, for example, he isolated the interesting sulfur-containing compound "thiasine" from blood corpuscles and later identified this substance with ergothioneine, which had hitherto only been encountered in ergot. In similar fashion he was led to the isolation from blood of a beautifully crystalline compound of uric acid and ribose, and the guess may be hazarded that this totally novel discovery gave him as much personal satisfaction as any of his other investigations. Benedict's work in the field of metabolism covered an extensive range. Many fruitful investigations were carried out on glycosurias of various types and on the creatine-creatinine problems, while his work on the relation of the kidney to ammonia formation and excretion was stimulating and distinctly upsetting to the currently accepted doctrines. For a long time Benedict was associated with the Memorial Hospital in New York City and in conjunction with his old pupil Sugiura was responsible for a vast amount of useful information concerning the influence of various chemical and other agents on the growth of tumors.

In 1920 it became necessary for various reasons to find a new home and new managing editor for the *Journal of Biological Chemistry*. The home was provided through the generosity of Cornell University Medical College, and in spite of considerable hesitation, Stanley Benedict, who had long been one of the journal's most distinguished contributors, was at last persuaded to accept the managing editorship. The personal sacrifice involved was immense, but until the day of his death he gave of the very best that was in him to further the interests of the journal and the science that it represented. In this labor of love he was ably supported by Miss Smalley and her devoted associates. Probably few people except editors know much of the never-ending grind and human difficulties entailed in the successful editing of a scientific journal. The *Journal of Biological Chemistry* has indeed been fortunate in this respect, and Benedict has set a standard that will not easily be surpassed. He was an editor who really edited and was not content to pass for publication indifferent material simply because it happened to originate from individuals or institutions of standing. To some extent he had Samuel Johnson's dislike of impairing the clarity of expression of his views or judgments by surrounding them with a sugar coating of innocuous words. He was direct, forceful, tenacious in argument, but absolutely unswayed in his judgments by any consideration other than the facts as he saw them. His intimates knew that under a somewhat stern exterior he was the kindliest and friendliest of men, with a keen sense of humor and a very charming smile. Indeed, Benedict was always susceptible to a little innocent raillery and would go more than half way to meet a joke. On one occasion in early days when as editor he had decided, against the views of at least one of his colleagues, to amputate a good many of the final "e's" that terminate the names of so many biochemical compounds, a solemn request as to whether he proposed similarly to abolish the final "e" in the name of his patronymic liqueur "Benedictine" brought an immediate suspension of operations.

Few men had less desire for honors than Benedict. He was a member of the National Academy of Sciences, a past president of the Society of Biological Chemists and received many other notable distinctions, all of which he bore with a refreshing lightness.

He was born in Cincinnati on March 17, 1884, son of Professor Wayland Richardson and Anne Kendrick Benedict. His father was professor of philosophy and psychology at the University of Cincinnati. His maternal grandfather was A. C. Kendrick, professor of Greek, Hebrew and Sanskrit at the University of Rochester and a member of the American committee for the revision of the King James version of the Bible. He graduated from the Universities of Cincinnati and of Yale, and taught at Syracuse University and Columbia University before going to Cornell University. In 1913 he married Ruth Fulton, of Norwich, N. Y., a well-known ethnologist, who survives him. He had also three sisters, each of whom has achieved professional distinction.

Benedict's memory will long be cherished by his university, by the journal he loved and served so devotedly, and by his many colleagues and friends, who found in him a source of both stimulation and good fellowship.

H. D. DAKIN

GRAFTON ELLIOT SMITH

SIR GRAFTON ELLIOT SMITH was so well known and had so many friends and colleagues in this country that some comment on his life and personality and his contributions to science may be acceptable, even though SCIENCE does not usually print obituary notices of foreign men of science.

With regard to his childhood and youth, not long ago he told one of his recent students that when he was a very young boy he began to collect fossil ferns, which were found near his birthplace at Grafton, New South Wales, Australia. When about fourteen years old he attended an evening lecture on the brain, in which the lecturer described the complexity of the convolutions of the human brain and added that many of these convolutions did not even have names or definite boun-

daries. He resolved not only to give them names but to discover their functions.

After studying anatomy and medicine at the University of Sydney, N. S. W., he took up the practice of medicine in that province. At that time, as he said, his youth protected him from having many patients, so he was free to collect the wonderfully primitive egg-laying and pouched mammals of Australia, to dissect them and to study the construction of their brains. His observations in this field were both original and important and led to the publication, chiefly in the leading English scientific journals, of a series of papers on the structure and evolution of the brain of the duck-bill (*Ornithorhynchus*) and other primitive or archaic mammals, including the South American edentates. In many cases he succeeded in showing that there was a definite relationship between the peculiar mode of life of the animal and the development of certain parts of the brain.

He left Australia to accept a fellowship at the University of Cambridge, and after two years was called to Cairo, Egypt, to become professor of anatomy at the Government Medical School. It was during this period that he extended his studies to the brains of primates, beginning with the lowly lemurs of Madagascar and Africa and working upward through the series to the "spectral tarsier" of Borneo, the marmoset and other monkeys of South America, the macaques and other Old World monkeys, finally to the anthropoid apes and man.

As a result of these and later studies, he gained an increasingly penetrating insight, first, into the progressive complications of the main regions of the brain during the course of evolution from fish to man and, second, into the relations between special areas and groups of brain cells on the one hand and particular responses on the other.

Since the elder Huxley was always his ideal, he spared no pains to translate even the most technical results into diagrams and simple descriptions which people of intelligence could readily comprehend, and no one who was ever privileged to hear him lecture would be likely to forget the experience.

At Cairo, his friend Professor (later Sir) Flinders Petrie soon plied him with delightful anatomical puzzles presented by the mummified remains from the tombs of the ancient Egyptians. Here his studies of the skulls and skeletons soon showed that the earlier Egyptians, who had narrow skulls, had been invaded at a certain period by a round-skulled people of Asiatic and more or less Armenoid appearance. The Egyptian embalmers took care to preserve the heart, kidneys and other organs separately and then to replace them within the body, and Professor Elliot Smith found that after certain restorative measures had been applied these ancient tissues could be sectioned, stained and studied under the microscope. This proceeding enabled him to hold post-mortem examinations on the bodies of persons who had been dead for several millennia. Moreover, he found that in certain cases the embalmers had made serious mistakes, transposing or omitting certain organs and presumably causing some rather embarrassing situations in the world of shades.

Almost in spite of himself, Elliot Smith extended his interests from purely anatomical fields to widening circles of cultural anthropology and it was indeed on this side of his career that he was best known to the world at large.

From Cairo he returned to England to occupy the chair of anatomy at the University of Manchester. For the past fifteen years he was head of the department of anatomy of University College, London, and there continued his work on the comparative anatomy of the brain but found time to write a whole series of books and papers in defense of his theory that civilization had originated in Egypt and had spread thence through Asia Minor and Persia to India, China and eventually to Central and South America. On this last topic he encountered the unanimous opposition of leading American archeologists and ethnologists, who maintained that in the case of at least the more advanced native American civilizations there is the most detailed and cumulative evidence of their having attained their peculiar cultural characteristics exclusively in the Americas, so that such resemblances as they do show to certain Old World cultures, as, for example, in the use of the truncated pyramid, the idea of the feathered serpent, the practice of mummification and the like, have more probably arisen independently in the New and Old Worlds through parallel or convergent development, that is, through similar reactions to similar situations, originating in the basic identity of human desires, motives and mentality the world over.

Elliot Smith took an active part in the study and discussion of the fossil Piltdown skull, the *Pithecanthropus* of Java, the *Sinanthropus* of China, as well as the *Australopithecus* of South Africa, the "Lady of Lloyds," and other fossil human crania. In these fields he sometimes contested the conclusions of his life-long friends, Sir Arthur Keith and Dr. Eugen Dubois, the discoverer of the *Pithecanthropus*, but the resulting discussions were invariably important, especially as aids in the sifting out of errors due partly to incomplete preservation of material.

Elliot Smith drew to his laboratories a notable assemblage of students and junior colleagues, among

whom may be mentioned: Davidson Black, the describer of the Peiping skull (*Sinanthropus*); Raymond Dart, describer of the *Australopithecus* of Taungs, South Africa; Wingate Todd, the well-known anatomist of Cleveland, Ohio; Frederic Wood-Jones, author of "Man's Place among the Mammals"; W. E. Le Gros Clark, author of "Early Forerunners of Man"; H. H. Woollard, author of monographs on the brains of *Tarsius* and other primates; H. A. Harris, now professor of anatomy at Cambridge University; Joseph Shellshear, formerly professor of anatomy at Hongkong University; D. E. Derry, of the Government Medical School at Cairo, Egypt; W. J. Perry, of the Section of Cultural Anthropology, University of London; John Beattie, Conservator of the Museum of the Royal College of Surgeons, London; Una Fielding, who, it is to be hoped, will complete and publish Elliot Smith's text-book of anatomy, and many others.

It is well known among his students and associates that Elliot Smith freely gave stimulating suggestions and ideas to those around him and gladly assisted them in the testing and development of both his own and others' problems. He was also admired and influential among English zoologists and vertebrate paleontologists, who followed his work, especially on the evolution of the brain, with keen interest. His work in cultural anthropology, although far more widely known, will not, in the opinion of many of his colleagues, constitute so enduring a monument to his memory as will his studies on the comparative physiology and evolution of the human brain.

On the side of public service, Elliot Smith was for many years the trusted adviser of the Rockefeller Foundation, which sent him on special missions to the United States, England, Egypt, China and other countries. It was doubtless due partly to his advice that the Rockefeller Foundation gave its powerful backing to the sciences of anatomy and zoology in all these countries.

In personal appearance, at least in his later years, Sir Grafton Elliot Smith somehow suggested the best portraits of George Washington. In his lectures there was a certain polish and grace joined to an intense sincerity and becoming modesty. He loved to tell jokes on himself, of which he had a choice collection. To him science knew no national boundaries and both as a man and a scientist his genial influence was felt in many countries, especially Australia, England, Canada, Holland, the United States and China.

WILLIAM K. GREGORY

AMERICAN MUSEUM OF NATURAL HISTORY

RECENT DEATHS AND MEMORIALS

DR. JULIUS O. STIEGLITZ, professor of chemistry and chairman of the department at the University of Chicago, died on January 10, in his seventieth year.

DR. FREDERICK V. COVILLE, botanist of the U. S. Department of Agriculture, with which he had been connected since 1888, died on January 9. He was sixty-nine years old.

DR. DAVID FRASER FRASER-HARRIS, secretary of the faculty of medicine of the University of Birmingham, England, and formerly professor of physiology at Dalhousie University, Halifax, N. S., died on January 3 at the age of sixty-nine years.

DR. R. F. C. LEITH, until his retirement in 1919 with the title emeritus professor of pathology and bacteriology at the University of Birmingham, died on December 14 at the age of eighty-two years.

LIEUTENANT COLONEL SIR DAVID SEMPLE, specialist in tropical disease, died on January 8. He was first director of the Pasteur Institute in India. On his retirement in 1905 he accepted service under the Government of India to organize the Central Research Institute of India. He was eighty years old.

Nature announces the following deaths: Sir Herbert Jackson, formerly director of the British Scientific Instrument Research Association, on December 10, aged seventy-three years, and Dr. A. A. Robb, author of works on aspects of relativity, on December 14, aged sixty-three years.

MEMORIAL exercises in honor of the late Julius Arthur Nieuwland were held at the University of Notre Dame on Sunday, January 10. Religious exercises took place in the morning. In the afternoon the program was presided over by the Rev. Francis J. Wenninger, dean of the College of Science, University of Notre Dame. Speakers taking part in the ceremonies and their subjects were as follows: "Father Nieuwland the Botanist," Dr. Marcus Ward Lyon, Jr., formerly assistant curator, U. S. National Museum; "Father Nieuwland the Chemist," William Stansfield Calcott, director, Jackson Laboratories, E. I. du Pont de Nemours and Company; "The Energy Balance of Star Systems," Dr. Arthur Haas, professor of physics, University of Notre Dame; "The Vanishing Floras of Northeastern America," Brother Marie Victorin, professor of botany, University of Montreal; "A Relativistic Theory of Atomic Structure," Dr. George David Birkhoff, Perkins professor of mathematics, Harvard University, and "Large Molecules in Science and Life," Dr. Hugh Stott Taylor, David B. Jones professor of chemistry, Princeton University.

SCIENTIFIC EVENTS

THE SOIL CONSERVATION SERVICE

THE annual report to the Secretary of Agriculture of H. H. Bennett, chief of the Soil Conservation Service, has been made public. He points out that the effectiveness of soil and water conservation at flood sources in minimizing floods is substantiated by several established facts:

1. Flood loads are due in large part to rapid surface run-off of rainfall or melting snow and the quick concentration of this water in stream channels.
2. The upland soils of a watershed constitute a storage reservoir capable of absorbing or retaining enough water to prevent, or at least greatly reduce, critical flood crests in the lower drainageways.
3. Proved and adaptable procedures to hold water in the soil are now available.

Mr. Bennett states that at the close of the year there was a wide-spread and growing conviction that the solution of the nation's flood problem lies in a coordinated watershed program of prevention and control in which the upstream farmer will reinforce with soil and water-saving practices the downstream fortifications of the engineer at critical areas of great danger. The former would prevent floods as far as possible and the latter would control critical flood crests when they do arise. To show the effectiveness of soil- and water-conserving practices in the alleviation of flood and drought conditions, Dr. Bennett cites data obtained by the Soil Conservation Service at its erosion experiment stations throughout the Great Plains.

The field activities of the service were considerably enlarged in the fiscal year. The number of demonstration projects was increased from 47 to 143 and the area of privately-owned land under cooperative agreement increased from approximately 4,000,000 to 7,000,000 acres. By July 1, 1936, nearly 18,000 farmers had signed voluntary agreements to cooperate with the service.

From a technical standpoint, the demonstration program remained unchanged during the year. It continued the introduction of such beneficial farming practises as strip cropping, contour tillage and contour furrowing; the construction of terraces, check dams and water-spreading dikes; woodland and gully plantings, and the retirement of steep slopes and badly eroded areas from cultivation.

More than 430,000 acres in the soil conservation demonstration projects, including the CCC camp areas, have been strip-cropped. Almost 200,000 acres have been contour-furrowed, and more than 900,000 acres have been tilled on the contour. Almost 38,000 miles of terraces, together with more than 200,000 terrace outlet structures, have been completed. Approximately 900,000 small dams have been built to check the run-off of rainfall and the spread of gullies.

In addition to these demonstration activities on private land areas, the service is conducting erosion control work on four large areas of federal and public land. These projects are the Navajo Indian Reservation of 17,000,000 acres in New Mexico and Arizona; the upper Gila River watershed, including the San Pedro and Santa Cruz tributaries, comprising 13,900,000 acres in New Mexico and Arizona; the Rio Grande watershed above Elephant Butte Reservoir, embracing 14,300,000 acres in New Mexico, and the entire Shoshone Indian Reservation of 2,400,000 acres in Wyoming.

RESEARCH PROGRAM OF THE FOOD AND DRUG ADMINISTRATION

AT the request of Secretary of Agriculture Wallace, the National Academy of Sciences, through its president, Dr. Frank R. Lillie, has appointed a committee for the purpose of reviewing the research program on the toxicity of lead and arsenic now under way in the Food and Drug Administration. The committee appointed by Dr. Lillie, that recently held its first meeting in Washington, consists of Professor A. J. Carlson, of the University of Chicago, *chairman;* Professor C. K. Drinker, of Harvard University; Dr. Ludvig Hektoen, McCormick Institute for Infectious Diseases and chairman of the National Research Council; Professor H. C. Sherman, of Columbia University, and Professor Torald Sollmann, of Western Reserve University School of Medicine.

The problem of the degree of toxicity of lead and arsenic occurring in the form of spray residues on fruits and vegetables has long been a troublesome one. Fruit and vegetable growers are obliged to use lead arsenate sprays to guard their crops against insect pests. Such sprays are useless unless they are sufficiently poisonous to destroy the insects. The residues remaining, if in sufficient quantity, are also dangerous to consumers. There is no difference of opinion among scientific men as to the poisonous character of both lead and arsenic. Authorities differ only upon the amounts of these poisons which may be consumed without damage to health.

The Food and Drug Administration of the Department of Agriculture has for years been carrying on a campaign under the Food and Drugs Act to remove from the market consignments of fruits and vegetables bearing what are considered dangerous amounts of poisonous residues. Other bureaus of the department have developed washing methods and appliances for

the removal of excess residues before the products are shipped, and these are in very general use, particularly in the apple industry. The present tolerances were adopted on the basis of advice given by a committee of toxicologists called together for consultation about ten years ago. That committee, in recommending the tentative tolerances which are essentially those now in effect, recommended further researches to fill out some of the gaps in scientific knowledge of the subject and determine more conclusively than has heretofore been possible at what figure permanent tolerances for lead and arsenic should be set to guarantee public health protection.

With an increase in appropriation for the enforcement of the Food and Drugs Act granted to the department two years ago by Congress, the Food and Drug Administration organized a Division of Pharmacology under the leadership of Dr. Edwin E. Nelson, who was furloughed by the University of Michigan, for the purpose of selecting competent personnel and formulating a comprehensive program of research on the toxicity of lead and arsenic as well as on other problems. Having completed the organization of the division, Dr. Nelson returned to the University of Michigan on October 1, where he is now professor of pharmacology. He continues to assist the division, however, in a consulting capacity. Dr. Nelson was succeeded as chief of the division by Dr. Herbert O. Calvery, biochemist. The division consists of twelve technically trained men, including eight biochemists and nutritionists, three pharmacologists and one pathologist.

As the first and most important subject for consideration by the new division, Dr. Nelson and Dr. Calvery outlined the research project for the study of the toxicity of lead and arsenic, which will be continued over a period of some years, with the objective of giving a scientific answer to the question as to what are safe tolerances for these poisonous substances.

THE ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA

THE forty-ninth annual meeting of the Geological Society of America was held at the Netherland Plaza Hotel, Cincinnati, from December 29 to 31.

Nearly six hundred persons registered for the meeting. The scientific program carried one hundred and fifteen titles, and the programs of the associated societies, the Paleontological Society and the Mineralogical Society of America, were also crowded.

The address of the retiring president, Dr. Walter C. Mendenhall, entitled "Outline of the Evolution and Present Status of Geology in North America," was delivered on the evening of December 29.

The annual dinner was held on the evening of the thirtieth. The ninth award of the Penrose Medal of the Geological Society of America was made at this time, the recipient being Professor Arthur Philemon Coleman, professor emeritus of the University of Toronto. The presentation address was made by Professor George D. Louderback, chairman of the Medal Award Committee.

On the afternoon of December 30, Dr. Isaiah Bowman made a radio address over Station WLW, entitled "Geology in the Evolution of Culture."

The officers of the society for the year 1937, elected at the annual meeting, are as follows:

President, Charles Palache
Past-President, Walter C. Mendenhall
Vice-Presidents, W. O. Hotchkiss, Charles Camsell, G. D. Harris, W. S. Bayley
Secretary, Charles P. Berkey
Treasurer, Edward B. Mathews
Councilors, Hoyt S. Gale, Chester R. Longwell, M. M. Leighton, Joseph T. Singewald, Jr., Walter H. Bucher, Russell S. Knappen, E. L. Bruce, Joseph Stanley-Brown, G. F. Loughlin

The following geologists were elected foreign correspondents:

Lucien Cayeux, Paris, France
Arthur Holmes, Durham, England
Louis de Launay, Paris, France

The following is the list of newly elected fellows:

John Emery Adams, Midland, Texas
John Hodgdon Bradley, Jr., Los Angeles, California
Carl Colton Branson, Providence, Rhode Island
Roland Wilbur Brown, Washington, D. C.
Edwin Harris Colbert, New York, N. Y.
George Vibert Douglas, Halifax, Nova Scotia
Lloyd Wellington Fisher, Lewiston, Maine
Paul Pavel Goudkoff, Los Angeles, California
Philip Krieger, New York, N. Y.
William Christian Krumbein, Chicago, Illinois
Ralph Maxwell Leggette, Jamaica, New York
Evans Blackmore Mayo, Bishop, California
Simeon William Muller, Stanford University, California
William Thomas Nightingale, Rock Springs, Wyoming
Henry Staats Sharp, New York, N. Y.
Victor Timothy Stringfield, Washington, D. C.
Charles Vernon Theis, Albuquerque, New Mexico
Norman Edward Weisbord, Sumatra, Netherland East Indies
Alice Evelyn Wilson, Ottawa, Canada

THE AWARD OF THE PERKIN MEDAL OF THE SOCIETY OF CHEMICAL INDUSTRY

THE William H. Perkin Medal of the American Section of the Society of Chemical Industry was presented to Thomas Midgley, Jr., vice-president of the Ethyl Gasoline Corporation, at a meeting on January 8 at the New York Chemical Club.

The medal was presented to Mr. Midgley "for dis-

tinguished work in applied chemistry, including the development of antiknock motor fuels and safe refrigerants." The presentation speech was made by Professor Marston T. Bogert, of Columbia University, past president of the American Chemical Society, of which Mr. Midgley is now chairman of the board of directors. Dr. Robert E. Wilson, vice-chairman of the Pan-American Petroleum and Transport Company, spoke on "The Life and Accomplishments of the Medallist." Mr. Midgley gave an account of his work in his address of acceptance, which was entitled: "From the Periodic Table to Production," in the course of which he paid the following tribute to his associates:

> Charles F. Kettering was a primary factor in solving the two problems for which I am rewarded. Without his guiding genius, faith, patience and financial support it is quite likely that neither Ethyl gasoline nor the Freon refrigerants would be in existence to-day. The assistance of T. A. Boyd and Carroll A. Hochwalt in the development which led to the discovery of the utility of tetraethyl lead in motor fuels can not be overemphasized. Albert A. Henne deserves fully as much credit as I do for developing the organic fluorides as refrigerants.

After graduating from the Sibley College of Mechanical Engineering of Cornell University, Mr. Midgley engaged in private research in tires until 1914, when he became superintendent of the Midgley Tire and Rubber Company, Lancaster, Ohio. Since 1920 he has worked in the General Motors laboratories in association with Mr. Kettering. He is vice-president of Kinetic Chemicals, Inc., and has contributed widely to the knowledge of the properties of natural and synthetic rubbers and methods of making better synthetic rubbers.

He is a fellow of the American Association for the Advancement of Science and a member of the American Institute of Chemical Engineers, the Society of Automotive Engineers, the Society of Military Engineers, the American Public Health Association, the Association of Cornell Engineers, and Sigma Xi, Phi Kappa Phi and Atmos. He has received both the Longstreth and Nichols Medals in recognition of his scientific work, and is the author of nearly fifty technical papers and the holder of more than forty patents.

Former Perkin medalists besides Sir William Perkin were: J. B. F. Herreshoff, Arno Behr, E. G. Acheson, Charles M. Hall, Herman Frasch, James Gailey, John W. Hyatt, Edward Weston, L. H. Baekeland, Ernest Twitchell, A. J. Rossi, F. G. Cottrell, Charles F. Chandler, Willis R. Whitney, William M. Burton, Milton C. Whitaker, Frederick M. Becket, Hugh K. Moore, R. B. Moore, John E. Teeple, Irving Langmuir, E. C. Sullivan, Herbert H. Dow, Arthur D. Little, C. F. Burgess, George Oenslager, G. O. Curme, Jr., Colin G. Fink, Warren K. Lewis.

Dr. Vail, chairman of the American Section of the Society of Chemical Industry, presided at the meeting, in which the New York Section of the American Chemical Society participated. The event was preceded by a dinner in honor of Mr. Midgley.

SCIENTIFIC NOTES AND NEWS

DR. RICHARD P. STRONG, professor of tropical medicine, Harvard Medical School, has been elected an honorary fellow of the Royal Society of Tropical Medicine and Hygiene, and has been invited to give the first Chadwick lecture in London during the present month.

DR. WILDER DWIGHT BANCROFT, professor of physical chemistry at Cornell University, has been appointed visiting professor of chemistry at Bowdoin College on the Tallman Foundation.

PROFESSOR G. A. MILLER, of the University of Illinois, was made an honorary life member of the Mathematical Association of America during its recent meeting at Duke University.

PRESIDENT ISAIAH BOWMAN, of the Johns Hopkins University, was granted the Distinguished Service Award of the National Council of Geography Teachers at the Syracuse meeting on December 30, in recognition of his contributions to geographic education.

DR. EDGAR ANDERSON, professor of botany at Washington University, St. Louis, and geneticist at the Missouri Botanical Garden, has been awarded the Order of the Yugoslavian Crown in recognition of his study of Balkan plants.

AT a ceremony at the University of Michigan, presided over by President Alexander G. Ruthven, on September 28, a portrait of Dr. Albert M. Barrett, director of the Psychopathic Hospital, was presented to the university by friends, alumni and associates of Dr. Barrett. It is the work of John Koch, of Ann Arbor.

THE twenty-fifth anniversary of the appointment of Professor S. O. Mast to the faculty of the Johns Hopkins University was celebrated at a dinner given in his honor at the Morton Hotel in Atlantic City on December 29. About forty of his present and former students and several of his colleagues and old college friends were present, as well as Mrs. Mast and two of their daughters. An oil portrait of Dr. Mast done by Hans Schlereth, of Washington, was unveiled. In addition, a bound volume of testimonial letters and a

handsome three-volume set of his 130 reprints were presented to him. Dr. H. S. Jennings acted as toastmaster, and toasts were given by Drs. C. Ladd Prosser, C. E. Bills, S. W. Geiser, W. N. Hess, O. S. Reimold, L. M. Bertholf, J. P. Visscher and W. L. Dolley, Jr.

AT the annual meeting of the Genetics Society of America held at Atlantic City officers for 1937 were elected as follows: E. M. East, Harvard University, *president*, and L. J. Cole, University of Wisconsin, *vice-president*. The secretary of the society is M. Demerec, Carnegie Institution of Washington, Cold Spring Harbor, New York.

THE Botanical Society of America, at its thirty-first annual meeting held at Atlantic City from December 29 to 31, elected the following officers for the ensuing year: *President*, Edmund W. Sinnott, Columbia University; *Vice-president*, Loren C. Petry, Cornell University; *Secretary*, George S. Avery, Jr., Connecticut College. Chairmen of the sections of the society elected or announced at this meeting are: *General*, E. N. Transeau, the Ohio State University; *Physiological*, E. F. Hopkins, Cornell University; *Systematic*, T. G. Yuncker, De Pauw University. A new section for paleobotany was organized, with the following officers: *Chairman*, A. C. Noé, University of Chicago; *Secretary*, W. C. Darrah, Harvard University. At the same meeting the following botanists were elected to corresponding membership: Dr. N. I. Vavilov, director of the State Institute for Experimental Agronomy, Leningrad; Dr. Agnes Arber, sometime fellow of Newnham College, Cambridge, England, and Dr. Lorenzo R. Parodi, professor of botany in the University of Buenos Aires.

THE American Microscopical Society held its fifty-fifth annual meeting at Atlantic City on December 30. The following officers were elected for 1937: *President*, Dr. W. W. Cort; *first vice-president*, Dr. O. E. Jennings; *second vice-president*, Dr. J. W. Scott; *secretary* (3 years), Dr. J. E. Ackert; *elective member of executive committee*, Dr. A. B. Dawson (3 years). Dr. Henry B. Ward, Dr. H. N. Lyon and William E. Dresher, who have served the society for fifty years, were elected to honorary membership. Dr. J. E. Ackert and Dr. A. M. Chickering were named to represent the society on the council of the American Association.

THE following members of the Indiana Academy of Science have been appointed divisional chairmen for the year 1937: *Archeology*, Glenn A. Black, Indianapolis; *Botany*, C. L. Porter, Purdue University; *Chemistry*, Paul D. Wilkinson, Indiana State Teachers College; *Bacteriology*, H. M. Powell, Eli Lilly Company, Indianapolis; *Geology and Geography*, Leroy Perkins, Indiana State Teachers College; *Mathematics*, C. K. Robbins, Purdue University; *Physics*, Leslie I. Steinbach, Central Normal College, Danville; *Psychology*, P. R. Hightower, Butler University; *Zoology*, W. P. Allyn, Indiana State Teachers College. Chairmen of the following standing committees have also been appointed: *Archeological Survey*, E. Y. Guernsey, Bedford; *Biological Survey*, B. E. Montgomery, Purdue University; *Library*, J. E. Potzger, Butler University; *Program*, Edward Kintner, Manchester College; *Publication of Proceedings*, J. J. Davis, Purdue University; *Relation of Academy to State*, F. N. Wallace, Department of Conservation. Dr. H. E. Enders, dean of the School of Science, Purdue University, has been selected as representative for the academy on the Council of the American Association for the Advancement of Science and as chairman of the Junior Academy of Science.

THE corporation of the Massachusetts Institute of Technology on January 7 elected, under a change in the corporation by-laws, five special-term members. The Technology Alumni Association nominates three term-members annually. The new members are: Edmund C. Mayo, president of the Gorham Manufacturing Company, Providence, R. I.; Gordon S. Rentschler, president of the National City Bank of New York; Ralph E. Flanders, president of the Jones and Lamson Machine Company, Springfield, Vt.; Frank D. Comerford, president of the Edison Electric Illuminating Company, Boston, Mass., and Halfdan Lee, president of the Eastern Gas and Fuel Associates.

PROFESSOR C. L. METCALF, head of the department of entomology at the University of Illinois, has been appointed chairman of the division of biological sciences, composed of the departments of bacteriology, botany, entomology, physiology, psychology and zoology.

ASSISTANT PROFESSOR W. D. BATEN, of the University of Michigan, has been appointed associate professor of mathematical statistics and research associate in statistics at Michigan State College. His work will include that of statistical adviser in the State College Experiment Station.

PREVIOUS awards from the Elizabeth Thompson Science Fund were reported in SCIENCE on November 29, 1935, and earlier. Since the last report the following awards have been made. At the meeting of April 8, $200 was awarded to Kurt G. Stern, Yale University, for an investigation of the chemical constituents of the enzyme catalase; $60 to Arthur Jacot, Appalachian Forest Experimental Station, Asheville, N. C., for duplicating Thomas Say's collection of mites and determining what were his species; $200 to Dr. H. S.

Jennings, of the Johns Hopkins University, to be administered in behalf of Dr. T. T. Chen's studies on the mechanism of heredity in unicellular organisms; $400 to Walter C. Michels and A. L. Patterson, Bryn Mawr College, for studies of the effects of x-rays on cell division and for crystal analysis.

DR. N. H. DARTON has been retired from the U. S. Geological Survey, after serving as geologist for more than fifty years. He will continue scientific work at the survey and will also engage in private practice with headquarters in Washington.

DR. WILLIAM THOMAS CALMAN retired from the British Museum (Natural History) on December 29, the day on which he reached the age of sixty-five years. Dr. Calman, who is president of the Linnean Society and secretary of the Ray Society, entered the museum in 1904, and has been keeper of the department of zoology since 1921. His special subject is the study of the crustacea. On the day of his retirement a number of his friends and colleagues presented him with a pencil portrait of himself, drawn by W. T. Monnington. The retirement on account of ill health is also announced of Guy Coburn Robson, deputy keeper in charge of mollusca in the department of zoology.

ALBERT PÉRARD, who has been connected with the International Bureau of Weights and Measures since 1905, since 1931 as assistant director, has been appointed director. He succeeds Dr. Charles-Edouard Guillaume, who has retired after serving in the bureau for fifty-three years and as its director since 1915. The title of "honorary director" has been bestowed upon Dr. Guillaume.

The British Medical Journal records the following retirements and new appointments: Professor Sobernheim, director of the Institute for Hygiene and Bacteriology at Berne, has retired and been succeeded by Dr. Kurt Hallauer, of Basle. Dr. Marinescu, professor of neurology at Bucarest, has been succeeded, on reaching the age limit, by Dr. Paulian, director of the Central Neurological and Psychiatric Hospital. Professor C. Kronacher, director of the Institute for Animal Breeding and Domestic Animal Genetics of the University of Berlin, has been given charge of the German Society for Animal Psychology, an institution created earlier this year. Dr. Leopold Arzt, professor of dermatology at Vienna, has been elected rector of the university; Dr. André Trèves has been elected president of the Paris Surgical Society.

DR. WILFRED H. OSGOOD, chief curator of zoology at the Field Museum of Natural History, sailed on January 9 from Vancouver for French Indo-China to collect birds and mammals for the museum. The chief objectives of his expedition are specimens for a proposed habitat group of gibbons and for a group of Argus pheasants. Dr. Osgood will also collect a wide variety of small mammals, birds, reptiles, etc. He will remain in French Indo-China and neighboring territory for four months or more, working principally in the southern regions.

PROFESSOR ELLINOR H. BEHRE, of the Louisiana State University, is taking the place during the first semester of Dr. Elizabeth Adams, of the department of zoology at Mount Holyoke College, who is absent on leave. Dr. Adams is visiting laboratories where endocrine investigations are in progress, including McGill University, the University of Buffalo, the University of Chicago, the Mayo Clinic, the University of Iowa and the Johns Hopkins University.

VISITORS to the College of Natural Science of Yenching University, Peiping, China, during the autumn of 1936 included: Dr. O. R. McCoy, professor of parasitology at the School of Medicine and Dentistry of the University of Rochester; Miss Carey D. Miller, of the Nutrition Laboratory of the University of Hawaii; Dr. A. C. Fraser, professor of plant breeding at Cornell University; Dr. P. G. Rahm, visiting professor of biology at Fu-Jen University, and Dr. B. Suzuki, professor of biological chemistry at Tokyo Imperial University.

DR. GEORGE W. CORNER, professor of anatomy in the University of Rochester, has returned from England. During his visit there he presented, in addition to the Vicary Lecture of the Royal College of Surgeons, a series of lectures on the ovarian hormones, under the auspices of the University of London and Guy's Hospital Medical School on December 7, 8, 9 and 11. He lectured also at the University of Manchester on December 14, and at the Edinburgh Obstetrical Society on December 15, on "The Corpus Luteum and its Hormone," and at the University of Edinburgh on December 15 on "The Ovarian Hormones and the Menstrual Cycle."

DR. R. SCHOENHEIMER, assistant professor of biological chemistry of the College of Physicians and Surgeons, Columbia University, will deliver the fourth Harvey Society Lecture of the current series at the New York Academy of Medicine on January 21. He will speak on "The Investigation of Intermediary Metabolism with the Aid of Heavy Hydrogen."

THE sixty-sixth annual meeting of the American Public Health Association will be held in New York City from October 5 to 8. The last annual meeting took place in New Orleans last October. It attracted an attendance of 1,650 health authorities representing forty-five states, Canada, Cuba, Mexico and nine other

foreign countries. The National Organization for Public Health Nursing will meet with the association in 1937 for the first time. This organization will, it is expected, add another thousand members to the registration lists. The following related societies will meet with the association as usual: The American Association of School Physicians; International Society of Medical Health Officers; Conference of State Sanitary Engineers; Conference of State Laboratory Directors; Association of Women in Public Health and Delta Omega. Dr. Reginald M. Atwater is the executive secretary of the association, and the headquarters offices are at 50 West 50th Street, New York, N. Y.

DISCUSSION

THE DISTRIBUTION OF BLACK WIDOW SPIDERS

IN a recent article by D. C. Lowrie[1] the geographic distribution of the black widow spider, *Latrodectus mactans* (Fabr.), is discussed. The author adds Indiana to the list of states from which the spider is known and refers to the records given two weeks previously by L. H. Townsend[2] for Illinois and Oregon as though they were the first for those states. Moreover, he makes a statement to the effect that it has not yet been recorded from the following states: Minnesota, Iowa, Virginia, Delaware, New Jersey, Connecticut, Rhode Island and Vermont. A few weeks later Jeffers[3] recorded the spider from Virginia. There is no doubt that it occurs in all these states, as it has been found in the regions bounding them. As a matter of fact, records for some of them have been available in entomological literature. For the benefit of those interested who may not have access to this literature I repeat them here.

For Virginia the spider was first recorded by J. H. Emerton[4] in 1875, from Hog Island. It has also been recorded as abundant in the Norfolk area by L. D. Anderson and H. G. Walker,[5] and from various localities by C. R. Willey.[6] Moreover, Dr. Bogen[7] cites cases of arachnidism from this state and gives three medical references. In a supplementary paper[8] two more references are added.

For Illinois the spider has been recorded by W. J. Spicer[9] from near Pittsfield, near Springfield and from Barry. For Oregon, by H. H. Stage[10] from Klamath Falls, and by D. C. Mote[11] from Roseburg and elsewhere.

For New Jersey the spider has been recorded by C. H. Hadley[12] from Moorestown, and by R. C. Cassel-bury[13] from near Ocean City. For Rhode Island a specimen from Cranston has been recorded by A. E. Stene.[14] Specimens have been collected in Connecticut at Killingworth on May 16, 1933, by Dr. A. Petrunkevitch; at North Plains on October 28, 1934, by Dr. S. C. Ball; at Norwichtown on June 25, 1935, by A. Latham, and at Leetes Island on September 29, 1935, by D. S. Riggs. These have all been recorded by Dr. W. E. Britton.[15]

In addition to the above the following records are published for the first time. In Connecticut a specimen was taken by P. G. Howes at Stamford in 1912; by V. R. Short at Westbrook on June 8, 1935; by Mrs. W. Harrington at Woodbridge on October 7, 1936; by Mrs. I. J. Longo in Bridgeport on September 15, 1936, and two were found by D. S. Riggs in the nest of a mud dauber wasp at Cheshire on August 19, 1936. In Vermont specimens were collected in June, 1935, by Miss E. B. Bryant at Brandon and by C. H. Paige at Woodstock.

B. J. KASTON

CONNECTICUT AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN

[1] SCIENCE, 84: 437, November 13, 1936.
[2] *Ibid.*, 84: 392–393, October 30, 1936.
[3] *Ibid.*, 84: 533–534, December 11, 1936.
[4] Occ. Papers Boston Soc. Nat. Hist., 2: 153, 1875. (In reprint of N. M. Hentz's "Spiders of the United States.")
[5] *Insect Pest Surv. Bul.*, 12: 404, November, 1932.
[6] *Ibid.*, 14: 296, November, 1934.
[7] *Arch. Int. Med.*, 38: 623–632, November, 1926.
[8] *Ann. Int. Med.*, 6: 375–388, September, 1932.
[9] *Insect Pest Surv. Bul.*, 15: 419, November, 1935.
[10] *Ibid.*, 14: 164, July, 1934.
[11] *Ibid.*, 14: 209, August, 1934.
[12] *Ibid.*, 15: 389, October, 1935.
[13] *Entom. News*, 46: 260–261, December, 1935.
[14] *Insect Pest Surv. Bul.*, 16: 306, August, 1936.
[15] *Conn. Agr. Exp. Sta. Bul.*, 383: 350. April, 1936.

THE BLACK WIDOW SPIDER IN VIRGINIA

As G. W. Jeffers states in SCIENCE for December 11, 1936, it is rather surprising that the black widow spider *Latrodectus mactans* has not been recorded officially in Virginia, although this is the case, according to D. C. Lowrie in SCIENCE for November 11, 1936. Jeffers finds it fairly common at Farmville, Va., and concludes that it probably occurs elsewhere in the state.

The writer has found it under boards at Arlington Farm, Va., near Washington, D. C., in the Alleghenies at Camp Todd, Augusta County, Va., at 1,000 feet, and at the foot of Walker Mountain near Deerfield, Augusta County, Va., all within the last two years.

Many years ago the writer found it very abundant at Thompsons Mills near Hoschton in northern Georgia. At this time little mention was made of this spider and the writer strongly doubted the venomous nature of its bite. Several attempts were made to test its bite between the fingers, but he could not get it to use its fangs.

On collecting trips as many as five or six were carried alive in the closed hand on several occasions with no effort on its part to bite.

These spiders seek concealment usually beneath boards, logs, bark and stones. They are easily reared from the cocoons, and if one is dropped on the floor of a box with a female she proceeds to suspend it in a web and watch over it. The process is repeated if others are dropped about, showing a rather marked solicitude for the nest.

The writer has liberated swarms of the young in an old woodpile near his garden, with no fear of being bitten. Much has been written within recent years about the evil ways of this spider, but there is little reason to fear its attacks and no reason to wish that it could be exterminated. In truth the writer has no desire to exterminate unconditionally even the rattlesnake or copperhead in its wildest haunts, so marvelously has nature designed the rattlesnake more especially, and in the New World alone. The true naturalist feels no cynicism because nature has placed these in our midst and would not rejoice at their complete extermination.

H. A. ALLARD
WASHINGTON, D. C.

THE SIMILARITY OF ACTION OF MALE HORMONES AND ADRENAL EXTRACTS ON THE FEMALE BITTERLING

IN a recent issue of SCIENCE the observation was reported by Barnes, Kanter and Klawans[1] that crude ether extracts of adrenal cortex can initiate the lengthening of the ovipositor of the female bitterling. It was also stated that crystalline androsterone did not produce a positive reaction with these fish. Both of these observations would seem to cast doubt on our contention that the phenomenon in question is evoked by the male hormone.[2]

We wish to point out that such a conclusion is not necessarily true. In the first place, the failure to get a positive reaction with crystalline androsterone in one experiment using two fish is hardly convincing. We have performed many experiments with crystalline synthetic androsterone and have seen a number of positive reactions.[3] Positive reactions are usually, although not always, obtained when the optimum dose and a suitable menstruum are employed. Synthetic testosterone[4] also has been found effective.

But how does the action of adrenal cortical extract harmonize with the male hormone hypothesis? Reichstein[5] has obtained a substance from the adrenal cortex which is capable of stimulating comb growth in the capon, *i.e.*, a compound resembling androsterone physiologically. Mason, Myers and Kendall[6] have oxidized a cortical substance, similar to cortin, into a ketone which also has the stimulating effect on the capon's comb. It thus appears that adrenal cortex contains one or more substances resembling androsterone. These, from our experience, would be expected to have the effect on the female bitterling which Barnes, Kanter and Klawans have found.

The relationship of the adrenals to secondary male characteristics has long been recognized. It is to be hoped that the interesting facts referred to in this note will lead to more definite knowledge in this field.

ISRAEL S. KLEINER
ABNER I. WEISMAN
DANIEL I. MISHKIND
THE DEPARTMENT OF PHYSIOLOGY AND BIOCHEMISTRY
NEW YORK MEDICAL COLLEGE

[1] B. O. Barnes, A. E. Kanter and A. H. Klawans, SCIENCE, 84: 310, 1936.

[2] I. S. Kleiner, A. I. Weisman and D. I. Mishkind, *Jour. Am. Med. Asn.*, 106: 1643, 1936.

[3] I. S. Kleiner, A. I. Weisman and D. I. Mishkind, *Proc. Soc. Exp. Biol. and Med.*, 35: 344, 1936.

[4] I. S. Kleiner, A. I. Weisman, D. I. Mishkind and C. W. Coates, *Zoologica*, 21 (Part 4): 241, 1936.

[5] T. Reichstein, *Helv. chim. acta*, 19: 223, 1936.

[6] H. L. Mason, C. S. Myers and C. C. Kendall, *Jour. Biol. Chem.*, 116: 267, 1936.

PARTHENOGENESIS IN THE GRASSES

IN the November 13th issue of SCIENCE the article on the "Possibility of Parthenogenesis in Grass" suggests that it may be the first report of parthenogenesis in the grasses. There are, however, at least three reported cases: The first by J. De Coulon, "Nardus stricta. Etude physiologique, anatomique et embryologique," *Mem. soc. Vaudiose sc. nat.*, 1: 245–332, 1923; the second by E. F. Gaines and H. C. Aase, "A Haploid Wheat Plant," *Amer. Jour. of Botany*, 13: 373–385, 1926; the third by Helge Stenar, "Parthenogenesis in der Gattung Calamogrostis," *Arkiv. für Botinik.*, 25: 1–8. 1 Taf., 2 fig., 1935.

E. L. STOVER
EASTERN ILLINOIS STATE TEACHERS COLLEGE

ALKALIZE, ALKALINIZE AND ALKALIFY

THREE words are recorded in standard English and American dictionaries to denote the operation of making a material alkaline. These words are "alkalize," "alkalinize" and "alkalify." The word "basify" appears too, but it is defined as meaning "to make into a base by chemical means," which is not equivalent to the other three. Although direct analogy would suggest "alkalinify" as the opposite of acidify, this word is not listed at all.

While acidulate and acidify are familiar enough, the nearly universal practice among chemical writers is to say "add alkali until alkaline" or something equivalent, rather than use the less cumbersome words, alkalize, alkalify or alkalinize. Perhaps if it were known

that these words are perfectly acceptable, more writers would employ them. This would make for greater simplicity and often for greater clarity in setting down laboratory directions.

So unfamiliar are alkalify, alkalinize and alkalize that many instructors have made a habit of correcting students of elementary chemistry who have used them. Yet "alkalize" has had recognized standing since 1749.

This year a greater number of students than average have sought to use "alkalize" in place of more round-about expressions of the same idea. Probably their practice was inspired by the advertisements of a certain laxative mixture, where the word is used rather loosely. But whatever the source of the stimulus, there is no reason why alkalize, alkalinize or alkalify should not have wider usage. Rather than reprove the students for using these words, we might well follow their example.

T. W. DAVIS

NEW YORK UNIVERSITY

SPECIAL CORRESPONDENCE

FOURTH ANNUAL TRI-STATE (ILLINOIS, IOWA, WISCONSIN) GEOLOGICAL FIELD CONFERENCE

GEOLOGISTS and students of geology in the three above-mentioned states participated in the annual tri-state field conference on October 31 and November 1. The conference was held this year in Calhoun and Jersey counties in central western Illinois. It was conducted by A. H. Sutton, University of Illinois, assisted by J. Marvin Weller, Illinois State Geological Survey.

The conference was attended by 117 persons, who traveled in 35 cars. Geologists from eleven universities, colleges and state surveys of the three states and representatives of six oil companies operating in Illinois were present. Invited guests of the conference included six persons from Washington University, St. Louis, Mo., one from Oklahoma A. and M. College and the manager of the Alton, Ill., *Telegraph*. The geology of the stops was described in a mimeographed log and a blue-print map, furnished each participant at the beginning of the conference. In addition each car was supplied with quadrangle topographic maps of the area visited.

The conference began at Hardin, Calhoun County, at 9 A.M. on Saturday. The first day's trip included eight stops in Calhoun County. The stratigraphic section studied during the day is summarized below: *Mississippian:* St. Louis, Spergen (Salem), Warsaw, Keokuk, Burlington, Sedalia (Fern Glen), Chouteau, Hannibal, Louisiana, Saverton. *Devonian:* Cedar Valley. *Silurian:* Joliet, Kankakee, Edgewood. *Ordovician:* Maquoketa, Kimmswick, Decorah, Plattin, Joachim, St. Peter.

Good exposures of all these formations were visited for examination and fossil collecting. Contacts between most adjacent formations were observed. The Cap-au-Gres faulted monocline was studied and discussed. G. E. Ekblaw, Illinois State Geological Survey, explained the origin of the terraces along Illinois River and gave a brief summary of the Pleistocene and recent history of the area. W. H. Twenhofel, University of Wisconsin, and J. E. Lamar, Illinois State Geological Survey, discussed problems of the St. Peter sandstone, comparing the formation in this area with that in the northern portion of the Mississippi Valley.

The annual dinner and general meeting was held at the Stratford Hotel in Alton, Ill., on Saturday night and was attended by 103 persons. No formal papers were presented, but geologic problems of the area were discussed. Dr. Ekblaw presented a more detailed summary of the geologic history than had been given earlier in the day.

On Sunday, November 1, the trip covered portions of Jersey County. Several of the stratigraphic units which had been examined the previous day were seen again, and the Cap-au-Gres structure was studied in more localities. The conference closed at noon on Sunday at an exposure of Pleistocene varved lake deposits which were made in a pond adjacent to the margin of the Illinoian Ice.

The conference will be held next year in Wisconsin under the leadership of Professor F. T. Thwaites, of the University of Wisconsin.

A. H. SUTTON

UNIVERSITY OF ILLINOIS

SPECIAL ARTICLES

BUILT-UP FILMS OF PROTEINS AND THEIR PROPERTIES

MANY proteins can exist in water as large spherical molecules, but they can also spread on water surfaces, giving elastic solid monomolecular films having great two-dimensional compressibility. The present paper describes experiments made to determine whether the methods[1,2] developed in this laboratory for studies

[1] I. Langmuir, *Jour. Franklin Inst.*, 218: 143, 1934.

[2] Katharine B. Blodgett, *Jour. Am. Chem. Soc.*, 57: 1007, 1935.

of monolayers of higher fatty acids are applicable to monolayers of proteins.

We have been able to transfer monolayers of protein from a water surface onto solid surfaces, where their thickness can be measured by optical methods and many new properties can be observed.

As a solid substrate upon which to build up such films we have found it preferable to use a surface already covered with a number of layers of barium stearate obtained by the method described by Dr. Blodgett.[2] For example, we use a plate about the size of a microscope slide consisting of highly polished chromium plated brass. If 37 to 47 layers of barium stearate are placed upon this plate, the interference colors observed with polarized light at large angles of incidence are so sensitive to changes in thickness of the film that an increment of 3×10^{-8} cm produces noticeable change of color. A single monolayer of protein thus produces a very striking color change. A further development of Dr. Blodgett's technique, using monochromatic light and a photocell to determine the relative reflectivities of adjacent steps, should make it possible to measure variations in thickness much less than 10^{-8} cm.

A monomolecular film of protein may be transferred to a solid surface prepared in this way as follows: The surface of distilled water in a tray is cleaned by scraping with a barrier. A narrow strip of paper is placed upon the water near one end of the tray. A platinum wire, to which a few particles of protein, such as egg albumin or pepsin, are attached, is made to touch the surface of the water and the monomolecular film spreads out from these particles, pushing ahead of it the floating paper strip. A small drop of purified oleic acid is then applied to the water on the other side of the paper strip, so that a surface pressure of about 30 dynes per cm acts upon the protein film. The paper strip indicates the boundary between the protein film and the oleic acid film.

MONOFILMS

A single monolayer of protein may now be transferred to the prepared plate in two different ways. In the first method, which we shall denote as Method A, the plate, held in a vertical plane, is lowered into water. The movement of the paper barrier toward the plate proves that the protein film is being transferred to the plate. The plate is then kept immersed in the water while the protein film is removed from the surface by scraping and by blowing any residual film to the opposite end of the tray, where it may be confined behind a barrier. The plate, when raised out of the water, comes out wet, whereas if the protein film had not been placed upon the plate, the plate would have shed water when it was withdrawn. After allowing the surface film of water to evaporate, examination of the plate with polarized light at angles near grazing incidence shows that the part of the plate to which the protein film has been applied differs markedly in color from the original stearate film. Comparing the color with that of stearate films having a known series of steps, it is seen that the thickness of a film of egg albumin obtained under these conditions is about 20×10^{-8} cm.

The second method of applying the protein film, which we shall call Method B, consists in lowering the prepared plate vertically through a clean water surface, then applying the protein film as before and raising the plate out through this film. The motion of the paper strip again shows that a protein film is transferred to the plate. However, since the plate comes out wet and at first shows no interference colors, it is evident that the protein film is not yet in contact with the plate but lies on a water film several microns in thickness. As the water dries, the protein film becomes attached to the substrate. This film has about the same thickness as that obtained by Method A.

It is remarkable that, although the prepared plate (without a protein film), lowered into clean water and withdrawn, comes out dry, it is covered by a thick water layer if the plate is withdrawn from water upon which there is a protein film. If before drying the slide, it is lowered into the water, the movement of the paper barrier shows that the protein film goes back on the water surface, notwithstanding the 30-dyne pressure exerted by the oleic acid. These phenomena at first suggest that the protein film acts through the water film, a distance of several microns, upon the stearate film on the plate and so modifies it that it remains wet. A closer examination of the process by which a stearate film sheds water proves, however, that this depends upon the presence of a line of contact between the water-air, the water-stearate and the air-stearate interfaces. This one-dimensional contact line is the seat of the phenomenon. The forces acting along this contact line which are enormously more intense than any that can be exerted by gravity on a water film of a few microns' thickness produce a "zipper-like" effect in closing up the space available for the water film.

The action of the protein film by which it prevents the shedding of the water is thus to be interpreted as evidence that the work of adhesion between the protein film and the stearate film is not sufficient to give a sufficiently strong zipper action. The film of water is then about twice as thick as that occurring on a *clean* glass slide withdrawn from water, since the water film, descending only by gravity, is confined in the first case

between two stationary surfaces (the plate and the protein film), while in the case of the glass slide one surface of the water is free.

MULTIPLE FILMS

We have found it possible to build up multiple protein films under certain conditions. To classify the types of film obtained let us use P to denote the plate, R for the hydrocarbon surface upon it (barium stearate layers with CH_3 radicals forming the surface), A and B for protein layers produced by Methods A and B, respectively. Thus, for example, PRAB denotes a prepared plate upon which there is an A film covered by a B film.

PRAB FILMS

By dipping a plate into water covered by a protein film, withdrawing it and drying the water film, two layers of protein can be transferred to the plate. The thickness indicated by the color change is approximately twice that of a single layer. With pure water as the liquid substrate we have not succeeded in repeating this process to build up films having the structure PRABAB. If a PRAB film is lowered into pure water or into water covered by a protein film, even under 30 dynes/cm pressure, the B film is ejected from the plate on to the water surface. This is evident from the motion of the paper strip. The loss of the B-layer from the plate when it is dipped into the water has also been proved by withdrawing the plate through a clean water surface, drying it and examining the color.

The addition of zinc chloride to the water (10 mg per liter) prevents the separation of the B from the A layer and makes it possible to continue adding AB layers indefinitely giving PRABABAB ... films. In this way 30 layers were built up without difficulty and the thickness as indicated by color increased in proportion. We believe that very accurate measurements of the thickness of the films can be made in this way. They should also be useful for study of structure by x-ray and electron diffraction.

PRBBB ... FILMS

Successive B films can be built up, even without adding zinc salts, by lowering the plate into clean water and withdrawing it through a protein film. The plate always comes out wet and the new layer must be dried on before the next one is applied. The dried-on B-films are not ejected from the plate either on immersing or withdrawing the plate.

PRBAB FILMS

After a single B film has been applied and dried, the plate takes up an A film if it is lowered through a protein film. When the plate is withdrawn through a clean water surface, a PRBA film is formed; if withdrawn, through a protein layer, PRBAB is formed. Further than this, we have not been able to go without adding zinc salts, since the last B film is ejected if the plate is lowered into water. We have not succeeded in producing PRAAA films, but with difficulty have obtained imperfect PRAA films.

All the types of films which we have been able to build using oleic acid pressure (30 dynes/cm) can be built without appreciably greater difficulty, using castor oil (about 15 dynes/cm) as piston oil.

PROPERTIES OF THE PROTEIN FILMS ON SOLIDS

The foregoing observations lead to the conclusion that there are some essential differences between A layers and B layers. For example, B layers which lie upon A layers are ejected on to the water surface on immersing the plate in water (in absence of zinc salts); whereas B layers upon B layers are not ejected. The methods used to form the layers indicate that A layers are turned upside down (inverted) in their formation, whereas the B layers are not inverted. Thus the outer surfaces of the A and B layers should be hydrophilic and hydrophobic, respectively.

The adhesion of B or A layers to a PR substrate is such that dipping into water does not cause the removal of the layer.

The fact that A and B layers preserve their identity after immersing in water indicates that they can not readily turn over. This supports the theory that they consist of a two-dimensional network rather than polypeptide chains.

The outer surfaces of both A and B layers are wettable by water and by hydrocarbons such as hexadecane, petrolatum, benzene and hexane, and show no striking differences in contact angles. If either A or B layers are partly covered by petrolatum and then a drop of water is placed on an adjacent place on the layer, it can be observed on tilting the plate that the water displaces the hydrocarbon. This action is considerably more marked with an A film than with a B film, and gives some evidence for the greater hydrophilic character of A.

The most striking evidence that the outer surface of A and the inner surface of B are predominantly hydrophilic is furnished by the ejection on to the water of a B layer, which rests upon an A layer. This action is undoubtedly caused by the affinity of this hydrophilic interface for water.

STEARATE FILMS BUILT UPON PROTEIN FILMS

When a prepared plate PR, partly covered by an A or B film, is lowered into water containing Ba salts covered by a stearic acid film, under 30 dynes pres-

sure, it is seen that the water rises on the PRA or PRB film (contact angle of about 40°), whereas it is strongly depressed on the PR portions (contact angle far greater than 90°). When the plate is withdrawn through the stearate film on the water, the PR portions come out dry (with two additional stearate layers), while the PRA or PRB portions are wet. After drying, the color indicates that two stearate layers have been added on top of the protein film. If the plate is again lowered and raised through the stearate film on the water all portions of the plate come out dry and two more stearate layers have been added to the whole plate. In this way it has been possible to sandwich any number of single protein layers between layers consisting of even numbers of stearate monolayers.

PERMEABILITY OF PROTEIN FILMS

The composition of built-up barium stearate films depends upon the pH of water.[8] With strongly acid water, pH = 3, the films are nearly pure stearic acid, whereas with pH = 9 they are nearly pure neutral barium stearate. At pH = 6.5 the barium content is about half of that in barium stearate.

Dr. Blodgett has found that the films of neutral barium stearate remain unchanged in color after immersing in benzene, but when the barium content is decreased by using a lower value of pH during formation of the film, the free stearic acid can be rapidly dissolved out of the film by benzene. Her measurements of refractive index of such films have shown that the change of color produced by immersing a part of the film in benzene is due to a change of refractive index of the film and not due to a change of thickness. Stearate films, from which free stearic acid has been removed, may be called *skeleton films,* since the barium stearate lattice remains unchanged, while the molecules of free stearic acid are removed, very much as the water molecules in a zeolite crystal can be removed without altering the silicate lattice.

If a drop of a liquid hydrocarbon such as petrolatum or hexadecane is placed upon a skeleton film, it shows a lower contact angle than upon a film of neutral barium stearate; but the drop can still be made to move about on the plate without wetting it. The drop, however, leaves behind it a trail of the same color as the portions of the stearate film which have not been dipped into benzene. Thus the hydrocarbon immediately returns into the holes left by the removal of stearic acid and restores the refractive index to its original value, 1.49 (values as low as 1.25 may be obtained with skeleton films).

Vapors of octane and decane brought into contact with skeleton films also cause the refractive index to rise to 1.49, but when the source of vapor is removed, evaporation of the hydrocarbon causes a gradual return to the original lower value characteristic of the skeleton. A large number of non-volatile organic substances in benzene solution can be introduced into the holes of a skeleton film by dipping the film into such a benzene solution, and the extent to which the film takes up these substances can be quickly and accurately determined by the color changes. Such films thus constitute molecular sieves which may be used to determine the sizes, shapes and surface affinities of organic molecules.

It has also been possible to place a few layers of neutral stearate upon fifty layers of acid stearate and to measure the rate at which benzene removes free stearic acid through the insoluble neutral layers. In a couple of hours practically all the free stearic acid (equivalent to 15 layers) can be removed from 50 layers of acid stearate through 20 layers of neutral stearate, whereas without the addition of the neutral layers the removal would have been nearly complete in 1 or 2 minutes.

The foregoing technique may be applied in several ways to study the permeability of protein monolayers to various organic substances.

Method C: A protein film (A or B) may be applied to a prepared plate of acid stearate and if desired covered by 2 or 4 additional layers of acid stearate. Then the plate is immersed in benzene for definite time intervals, after each of which the color is observed. Petrolatum, the vapor of a volatile hydrocarbon or a benzene solution of an organic substance, is then applied to the plate and the color changes are noted. The advantage of covering the protein film by additional stearate layers is that a hydrocarbon liquid does not wet the film. Without such additional layers, the hydrocarbon wets the protein layer and forms such a thick layer of liquid that interference colors are not obtained.

Method D: A protein film may be applied directly upon a skeleton film and the taking-up of hydrocarbons or other substances may be studied.

In measurements made by Methods C and D with monolayers of egg albumin we have found that protein films are very much more impermeable (of the order of 100-fold) to benzene, stearic acid and the lower aliphatic hydrocarbons than are equally thick films of neutral barium stearate. Protein films applied under 30 dynes/cm are more impenetrable (of the order of 10-fold) than similar films applied under 15 dynes/cm. Protein films seem to be almost wholly impervious to petrolatum molecules, for a skeleton film $PR_{45}AR_2$, over which a petrolatum drop has been made to pass,

[8] I. Langmuir and V. J. Schaefer, *Jour. Am. Chem. Soc.*, 58: 284, 1936.

undergoes no greater change of color than would be expected from the hydrocarbon that enters the two upper layers R_2. Without the A the color returns to that of the unskeletonized film.

Several observations on the rate of removal of stearic acid by benzene have given indications that an A film is somewhat more impermeable than a B film.

EFFECT OF SURFACE PRESSURE ON THE THICKNESS OF PROTEIN FILMS

The area covered by a film of egg albumin on water decreases to one half when the surface pressure is raised from 15 to 30 dynes/cm. The thickness observed with $PR_{41}B_5$ applied under 15 dynes pressure agrees well with the color of $PR_{41}B_4$ applied under 30 dynes/cm pressure. Thus the thickness of the two kinds of films transferred to the solid differs in the ratio 1.0 to 1.25, while on the water surface the ratio is 1 to 2.

This difference suggests that strong forces of adhesion act upon the protein film on the solid to hold it flat so that the spacing is determined by the C-C and C-N linkages. On the other hand, the presence of the many hydrophilic groups in the protein molecules enables the lower surface of the protein monofilm on water to become wavy and so get into better contact with water. This waviness would account for the marked compressibility on water and the relatively smaller compressibility when forced to lie flat on a solid surface.

We have made some preliminary experiments to devise methods for studying protein films at the interface between water and hydrocarbon. A piece of egg albumin attached to a platinum wire was brought into contact with the interface between a lens of petrolatum and the underlying water. The lens was rapidly deformed in shape and in places made so thin that interference colors were obtained. The duplex films[2,4] thus produced are remarkably stable, as there is no tendency for the petrolatum to peel back, leaving a monolayer of protein on the water. The method just described is apparently not suitable for the formation of a uniform duplex film. A substance such as egg albumin, however, can be introduced as a water solution under the petrolatum. As the spherical molecules come into contact with the film, they appear to unfold into monolayers at the interface. Duplex films produced in this or other ways should afford a useful way of studying interfacial protein films. The preliminary observations show that such films are elastic solids of high compressibility, very much like protein films on water. With stearic acid, films at a water-air and an oil-water interface are very different, usually being condensed in the first case and gaseous in the second.

Most of the experiments described in this paper have been carried out with egg-albumin on distilled water brought to about pH 7 by the addition of a trace of ammonia. In some cases we have changed the pH to 3 and to 10 but have not observed any marked differences in behavior. A few experiments with pepsin and insulin have shown similar behavior. Undoubtedly by the application of these methods, quantitative differences will be found between the proteins which form monolayers on water.

The addition of formaldehyde to the water under a protein film has been found to decrease greatly the compressibility of these films, presumably by forming new cross-linkages which prevent the waviness of the lower surface or hold the waves more nearly rigid.

The properties of proteins shown by our experiments seem to be in accord with the view that the protein monolayer is a two-dimensional network held together by strong elastic springs and are not in accord with a structure consisting of polypeptide chains.

IRVING LANGMUIR
VINCENT J. SCHAEFER

RESEARCH LABORATORY,
GENERAL ELECTRIC COMPANY,
SCHENECTADY, N. Y.

D. M. WRINCH

MATHEMATICAL INSTITUTE,
UNIVERSITY OF OXFORD

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PREHISTORIC ARCHEOLOGY, PAST, PRESENT AND FUTURE[1]

By N. C. NELSON
AMERICAN MUSEUM OF NATURAL HISTORY

PREHISTORIC archeology as a method of solving the problems of man's physical origin and cultural development may be traced back almost two hundred years, but it was not until past the middle of last century that the inquiry became a recognized science. The long interval is marked by several important discoveries, as well as by sporadic efforts to get systematic investigations under way; but, owing to the long established adverse speculations of poets and book scholars, little headway was possible in the observational field until after 1859, when the growing prestige of the natural science movement finally swung the balance in favor of the visible facts and so opened the road to free inquiry. Since then the spade has been steadily in service, and by degrees the earth has yielded up an abundance of relics in nearly every quarter. Interpretation of the evidence thus obtained has kept close pace and is continually being rectified as new facts accumulate. The outstanding results of these research activities are that in the short span of seventy-five years the story of human existence has been stretched from the 5,000 years or so covered by written documents to a million years or more and we are beginning dimly to see the general course of progress from near the time when man first took to making implements and thereby differentiated himself once and for all from the rest of animal creation. The picture may never be fully developed as to its minor details, but the grand outline is permanently fixed and is clear enough for any school child to see and appreciate. Under the circumstances, if the astronomers are permitted to startle us with their idea of a rapidly expanding physical universe, there is no

[1] Address of the vice-president and chairman of the Section on Anthropology, American Association for the Advancement of Science, Atlantic City, December, 1936.

reason why the archeologists should not be allowed to point with equal pride to a similarly expanding human world.

The story of this archeological feat has not yet been adequately told. Zeal for gathering facts for and fitting the same into the general scheme of culture history has tended to obscure latent interest in the progress of the investigation itself. The lack is explainable also by the fact that the work until near the beginning of the present century was done as a rule not by seasoned professionals but by amateurs—men and women from every walk of life, scholastically trained and otherwise. This understandable universal appeal of things prehistoric has naturally been a mixed blessing. On the one hand, much of the earlier collected data are without accompanying information and therefore of comparatively little scientific value. On the other hand, the differently trained non-professional workers have contributed a great deal in the way of varied keen observations which are now embodied in archeological technique and which have helped to place the investigation on a broad and sound basis. Out of all this, in the natural course of events, professionally trained teachers and workers have lately come forth, prepared not only to appreciate what has been accomplished but also to plan the researches still required. All in all, the time seems ripe for a brief account of the past history, the present status and the future demands of our science.

Historical Development

The first beginnings of prehistoric archeology, though comparatively recent, are still veiled in obscurity. It must suffice to say that just as astronomy was preceded by astrology and chemistry by alchemy, so archeology was preceded by a similarly pseudo-scientific pursuit which we may call antiquarianism. The antiquarians and other hobbyists are still with us, probably always will be and certainly always have been, for we know from archeological sources that early man—in common with some of the lower animals—was endowed with the instinct for collecting rare and peculiar objects of all sorts. We are not surprised, therefore, to learn that a labeled display of relics was found in one of the rooms recently excavated in the palace at Ur, dating from about 3000 B.C. In addition, there are reasons for believing that fossils and other curios—probably stone implements—were kept in some of the Greek temples of the first millennium B.C. Historians vie in telling us of the somewhat later great museum at Alexandria, though no one seems to know what was in it besides manuscripts. We have read also of the royal curio collections kept at the various medieval European courts and which in modern times have given rise to some of the existing national museums. One might go on to cite contemporary descriptive and explanatory studies of such relics, were they not for the most part of questionable value in that they all fall within the range of endeavor that we have called antiquarianism, as distinguished from archeology proper. The essential difference in aim between the two pursuits lies in this, that while one values specimens chiefly for their own sake, as objects of art or as curios pure and simple, the other regards specimens primarily as means to an end, that end being the elucidation of culture history. Antiquarianism may fulfil a legitimate function, but its interests are sentimental rather than scientific, inspirational rather than informative.

The actual rise of prehistoric archeology should some day form an instructive chapter in the history of science. In the occidental world, up until the revival of interest in pagan learning in the fifteenth century, there was no room for even the concept "prehistoric." The world with all it contained was regarded as less than 6,000 years old and its entire history as somehow covered by written documents. These authoritative writings, including the Old Testament, Homer, Herodotus, Aristotle and others, had little to say about stone implements and nothing whatever about a Stone Age. On the other hand, even such enlightened pagan writers as Lucretius and Ovid, who speculated about the rise of man and culture, actually postulating a Stone Age, probably did not recognize *as such* the genuine stone implements that they may easily be supposed to have seen in public and private curio collections of their day. For stone implements were known to the Greeks and Romans, as well as to western Europeans of later times; but from before the beginning of our era down to as late as 1800 they were variously regarded as of superhuman and non-human origin. The oldest and longest-lived explanation was that they were thunderbolts, *i.e.*, objects formed in the air when the lightning flashed and as such endowed with magical properties, including the ability to protect against lightning. This old idea, as is well known, still prevails in many parts of the world. In later times recognized scholars also explained stone implements as natural products generated in the earth in the same way as fossils, as petrified iron implements, as symbols of the weapons wielded by the thunder god Thor, and finally as man-made implements used for ritual purposes, like the Jewish circumcision knife, which in Old Testament times continued to be made of flint.

Into the midst of this dark and scientifically hopeless world view a revealing ray of light had been suddenly thrown, following the year 1492, by the discovery in America and in the Pacific Islands of peoples who carried on for the most part with stone implements. But while this doubtless astounding phenomenon was

observed by Europeans from many walks of life and the news carried home, the acknowledged fact was explained for some time simply as due to cultural degeneration following as the natural result of mankind's dispersal from the Tower of Babel and so lost its significance for the stone implements found in Europe. A hundred years actually passed before Michael Mercati, physician to Pope Clement VIII, in 1593 ventured in the light of the new knowledge to write that the European objects called thunderbolts were implements of stone made and used by early man. In the course of the seventeenth and eighteenth centuries at least ten other writers vainly sought to convince the contemporary book-ridden scholars that Europe had once passed through a Stone Age like that observable in America. However, by 1936, when Director C. J. Thomsen, of the newly founded National Museum in Copenhagen, after twenty years' labor on the pre-Christian antiquities in his charge published anonymously a small pamphlet setting forth substantial evidence for the reality of the successive Stone, Bronze and Iron Ages in northwestern Europe, the whole western world was ready to accept and to apply his chronological scheme almost without comment or criticism. Thus the first step was gained for the conception "prehistory," though at the time the admission of a Stone Age for Europe meant little more than its earlier admission for America. Human existence was still regarded as limited to the estimated 6,000 years and the scattered stone-using peoples, ancient and modern, as no older than the earliest historic nations of the Near East. The former were merely unfortunate groups who had wandered away from the original high centers of culture and as a result lost the art of metallurgy and became users of stone. In the meantime, however, from 1750 onwards—and mostly since 1790—many discoveries had been made, especially in cave deposits and valley terrace gravels, of human skeletal and artifact remains associated with fossilized bones of extinct animals not mentioned in the historical records. The significance of this rapidly accumulating body of data finally became clear to a number of representative English scientists, including Sir Charles Lyell, Sir Joseph Prestwich and Sir John Evans, who accordingly in 1859 announced themselves as convinced beyond all doubt of the geologic antiquity of man. The battle with tradition being thus won at last, prehistoric research on all lines has since gone forward in Europe without hindrance, and scarcely a year has passed that has not witnessed new and important discoveries.

While this to us fantastic struggle between fact and fiction was slowly progressing in Europe, her colonizing citizens were rapidly becoming acquainted with the antiquities of other lands. The American continent was the first to come under scrutiny, and as the conspicuous archeological features here—ruins, earthworks, shellheaps, petroglyphs, etc.—were less ancient and therefore more easily linked with their originators than were the similar features of Europe, their consideration never involved comparable problems. For South America, if we ignore incidental references by early explorers and conquerors to abandoned palatial habitations and to the ancient practice of grave robbing, we have our first formal description of the famous Tiahuanaco ruin in Bolivia dating from 1554. Brief accounts of this and other Andean architectural remains followed from time to time during the next 250 years; but, though small relics were collected and described from about 1850 onwards, planned excavation for such remains is not definitely recorded until 1875. For Middle America we have to wait until 1785, when the equally famous Palenque ruins in Chiapas were first described. This revelation, together with the impetus given by Alexander von Humboldt, a German scientist who traveled in northwestern South America and Mexico from 1799 to 1804 and whose archeological observations were published in 1810, appears to have revived or set on foot a permanent interest in Latin American antiquities. At any rate, following that date, numerous elaborate surveys of ruins were made in Middle as well as in South America; but barring a few desultory attempts, especially by the French during their occupation of Mexico between the years of 1861 and 1867, no elaborate excavations for minor artifacts were undertaken until, as in South America, about the year 1875. From that time onward fieldwork involving excavation of some sort has been widely extended and of late much improved by the introduction of stratigraphic methods.

Coming to North America north of Mexico, and particularly the United States, the story of archeology is less spectacular, though scientifically more satisfactory. Observation, here as elsewhere, began with the conspicuous superficial features and only by slow degrees arrived at the systematic excavation and study of movable artifacts. Leaving out of account nearly all individual reports, however significant, ranging from those of the Norsemen in Greenland of the year 982 onward, the first sign of general interest in our antiquities was a prolonged discussion, beginning about 1680, bearing on the New England petroglyphs, such as those on Dighton Rock in Massachusetts. The second flare-up of popular interest came about the year 1780, or immediately after the Revolutionary War, when General Rufus Putnam and other military officers took up land in the Ohio Territory and at once began to send descriptive accounts of the mysterious earthworks of that region. This interest in the Moundbuilder remains died down at least twice, though it is

now again probably more alive than ever before. The third and last preliminary phase dates from 1849, when Lieutenant J. H. Simpson turned in the first detailed report on certain of the large ruins in the Southwest. This equally exciting though less mysterious discovery also suffered brief periods of neglect, but the field is at present receiving more scientific and popular attention than any other. The fourth or present phase, dating from about 1870, marks the beginning of shellmound investigations in California, in the Aleutian Islands, in Florida and elsewhere—a type of work which for results required much digging. Since that time, *i.e.*, since 1870, excavation methods—recorded from time to time as far back as 1784 when Thomas Jefferson employed them on a Virginia mound—have been applied in gradually improved form in all the indicated major fields. Also the investigation, here as in Latin America, has been geographically extended and to-day includes the outer borders of Canada, as well as Alaska, Greenland and the West Indies.

The particular aspect of American archeology concerned with the geologic antiquity of man deserves special mention. Until recently the inquiry has been handled mostly by geologists and paleontologists with results far from satisfactory. The topic was suggested in concrete form as early as 1772, when Peter Kalm published his notes on certain long previously reported finds of artifacts in the Quaternary deposits of New Jersey. It was broached again in 1835 by P. W. Lund's discoveries in several Brazilian caves of a considerable amount of human skeletal material apparently associated with bones of extinct animals of Pleistocene age. Neither contribution appears to have stirred up any comment at the time, however, and the subject did not become really alive until after 1850, when the occurrence of cultural and skeletal material, including the famous Calaveras skull, began to be reported from the Tertiary gold-bearing gravels of California. These alleged discoveries were reviewed between the years 1866 and 1879 by the geologist J. D. Whitney, who in 1880 published his report accepting the evidence as proving man's existence in America perhaps as early as Miocene times. During the same period, or between the years 1861 and 1867, French scientists contributed a number of suggestive finds from Mexico, which, though briefly reported by E. G. Tarayre in 1884, appear never to have been discussed. More successful in gaining notice were the numerous startling discoveries, beginning in 1870, by Florentino Ameghino in the Pampean and earlier formations of Argentina, on the basis of which man's, or rather proto-man's, antiquity was traced back to Eocene times! Almost simultaneously with these extravagant claims, *i.e.*, in 1872, Dr. C. C. Abbott began to report the occurrence of supposed stone implements of Paleolithic type in the Quaternary gravels of Trenton, New Jersey. Other widely scattered finds of lesser import have been reported from time to time before and since, until to-day there are at least two hundred of them recorded in the literature. But in the meantime the lively discussion, started about 1870, died down by 1890 and was not revived again in full force until 1916, with new and better authenticated discoveries, this time in Florida. Since 1927 the centers of interest have been transferred to Ecuador and to the Rocky Mountain states, archeologists have joined in the search, and the investigation is now at last placed on a thoroughly sound footing, with results that are more nearly in keeping with what is known from the rest of the world.

The remainder of the habitable world, in spite of its size, need not detain us long because prehistoric studies are here of relatively recent date. Europeans were comparatively slow to invade both Asia and Africa, though in one way or another they had known something about these realms since long before America was discovered. But even after their arrival they found in those continents only a few conspicuous monumental remains such as had excited attention in Europe and America. Nevertheless, referring to Africa, surface collecting can be traced back to 1855 in Cape Colony, to 1866 in Egypt, to about 1885 in Algeria and the northwest, to 1893 in East Africa and to about the same date in the Congo region. However, the first planned excavations appear to date back only to about the beginning of the present century and to have been at first confined mainly to Egypt and the French northwest. Adequate stratigraphic work is an achievement of the last ten years and at present is receiving special though not exclusive attention in Egypt and East Africa.

Archeological developments in Asia, if we omit reference to historic or classical studies, cover about the same length of time; but progress here has been more slow and steady than in Africa. Of preliminary surface collecting little is known except for early paleoliths first reported in India in 1863 and for neoliths first brought from Yunnan in 1870. But already during the decade 1860 to 1870 Wilhelm Radloff had made random excavations in Neolithic, Bronze and Iron Age sites in western Siberia. This was followed in 1879 by E. S. Morse's introduction of shellmound excavation in Japan and by the beginning of French excavations in the Caucasus region, by Upper Paleolithic discoveries in Siberia in 1884 and by Eolithic discoveries in Burma in 1894. With the turn of the century, in 1902, excavations began in the Neolithic and possibly Paleolithic caves and shellheaps of French Indo-China and also in a large partly

Neolithic mound at Susa in Mesopotamia. The latter type of work was duplicated in 1904 in two large Neolithic and Metal age mounds at Anau in Russian Turkestan. Finally, in 1905, several caves thought to exhibit Upper Paleolithic remains were tried out in the island of Ceylon. There followed apparently a brief lull in most places, incidental perhaps to the Great War, but since then activities have picked up again and are going forward on a grand scale in various sections of northern, middle and southern Asia. Incidentally, the work here as everywhere else was initiated by occidentals but is now taken part in if not, as in Japan, conducted entirely by native-born investigators.

When we turn finally to the great island world occupying the Pacific and Indian oceans our story is still more brief. Conquest and settlement of the Philippine and East Indian portions date from the sixteenth century, but Australia and the rest were not occupied until 1788 and later. Leaving the *Pithecanthropus erectus* find in Java out of account as perhaps a missing link not yet provided with implements, little archeological information has been available about this vast region until the present century. Early knowledge was limited, on the one hand, to a number of more or less remarkable ruins and monumental remains scattered through the East Indies, Melanesia, Micronesia and parts of Polynesia, and, on the other hand, to a few surface pickings of stone implements chiefly from Australia, Tasmania, New Zealand and Hawaii. Since 1903, however, minor excavations have been made in Celebes, the Philippines, Formosa and perhaps farther east; but the only really stratigraphic excavations have been carried out in Java and Australia respectively within the last ten and six years.

PRESENT STATUS

After all these mostly dry historical details it will be a relief to consider briefly what prehistoric archeology has actually accomplished during its short period of activity. From what has been said it should be apparent that most of the habitable world has been at least superficially explored and that to-day we have a fairly clear idea of the archeological possibilities of even the most inhospitable regions. Thus, omitting the little known interiors of Borneo and New Guinea, we have for all the rest of the world, including tropical jungles and arctic tundras, at least some descriptive information about conspicuous architectural and other fixed antiquities. The less forbidding localities, like the great deserts, have yielded in addition large collections of surface-gathered artifacts. Regions nearer the present centers of civilized life, particularly those of the temperate zones, have been subjected besides to more or less extensive random excavation for the purpose primarily of obtaining small relics. Lastly, in not a few places and naturally those favored for long periods by early man, systematized excavations, embodying stratigraphic methods where possible, are also well under way. This intensification of fieldwork, ranging geographically from the less favored towards the more favored regions of the world, is reflected also by the time order of research developments in the several main centers of archeological activity. That is to say, the general order of inquiry has everywhere been about as follows: first, discovery and description of monumental remains, as in our mound area; second, surface collecting and typological studies of movable remains, resulting sometimes, as in Africa, in the identification of culture centers; third, random excavation for small relics with the same end in view and including perhaps the approximate bounding, as in America, of culture areas; and, fourth, stratigraphic excavation, making possible a determination of the time order, if not also the technological evolution of the industrial stages within the given culture areas, as achieved for example in our own Southwest. Both of these general modes of progress have been more or less inevitable, not only because it was natural to begin with the conspicuous monumental remains but partly also because monumental remains often defy interpretation as to date and purpose except in terms of the small implemental objects that accompany them. For instance, in order to discover the function, say, of an earthmound, excavation may be necessary to learn that it was used for burial purposes. Again, to discover the relative date of the mound with its known skeletal and cultural contents it may next be necessary to excavate a local stratified culture deposit, such as a refuse heap, to obtain the time position of the implemental trait combination as found in the mound. In other words, because the evolution of stone implements or of pottery is longer, more uniformly varied and therefore more easily understood with respect to the all-important element of time order, chronological determinations for all other associated culture traits are most easily worked out through the employment of these better known media.

Turning to the different areas of the world field, present achievements may be briefly summarized. In the case of western Europe all known monumental features, including cave art, have been described, immense collections have been accumulated, typological studies have long been in progress and stratigraphic investigations are in an advanced state, as is indicated by chronologically arranged museum exhibits. The stratigraphic method has been applied wherever possible: to artifact inclusions in geologic formations, to artificial cave debris, to shellheaps, to pile-dweller deposits and to superposed ruins. In some countries,

like Denmark, the available chronological outlay from the Iron Age back through the Bronze Age, the Neolithic period, and into the final phase of the Mesolithic period appears to be completely set in order; while elsewhere, as in France, the preceding Paleolithic succession is gradually being pieced together and extended until it seems as if the whole story of cultural evolution is complete at least as far as time order is concerned. All these cultural stages and sub-stages have been tentatively correlated with the whole range of oscillating climatic changes characterizing the Quaternary geologic period, now estimated to have endured for about a million years; and those who champion eoliths have taken cultural beginnings back several million more years, through Pliocene and into Miocene times. Incidentally, in Sweden an absolute chronology has been worked out for post-glacial time by the counting of annual silt deposits. Also incidentally, at least some light has been thrown on the general succession of racial types in Europe. These accomplishments have all been made intelligible to the interested public through museum exhibits and through a series of semi-popular handbooks such as are available for no other part of the world.

In America the archeological field has been cultivated, if perhaps less intensively, at least as long and as extensively as in Europe. As evidence of this we have long possessed elaborate descriptions of ruins, mounds and petroglyphs; we have several more recent studies of mines, quarries, workshops, cave habitations and village sites, including shellheaps; and our very large semi-scientific collections have received typological treatment in both formal reports and semi-popular handbooks. Lastly, our stratigraphic investigations, begun in earnest about thirty years ago, have now been applied to both natural and artificial deposits and are well under way, for example, in the Southwest, in California, Florida, New York and Nebraska, in Mexico valley, in Andean South America and even of late in Alaska and Tierra del Fuego. One important result of all this labor is that man and culture in America can now safely be carried back some as yet uncertain distance into post-glacial time. Another is that we perceive here an independently developed segment of cultural evolution embracing what in Old World terms might be called the Late Paleolithic, Neolithic, Copper and Bronze Ages.

In Africa, except for bare descriptions of Mediterranean shore dolmens and a little excavation in some late Rhodesian ruins like those of Zimbabwe, archeological investigation has until lately been confined to Stone Age remains. These remains include shellheaps, cave-wall art and small artifacts. Of the last large surface collections have been made and independent preliminary typological studies of these have resulted in a confusing lot of names for localized and slightly differentiated culture complexes, seemingly in need of correlation and simplification. But assistance is now apparently on the way, for during the last few years much stratigraphic work of one kind or another has been carried out, especially in the Nile valley gravel terraces and in various types of natural and artificial deposits in Kenya Colony. In the latter region it is claimed, incidentally, that human existence, as judged by both cultural and skeleton discoveries, can be traced back, as in Europe, to the beginnings of Pleistocene if not to Tertiary times. Speaking generally, Africa seems to be strong on Lower Paleolithic flint industries, weak, except in the northwest, on typical Upper Paleolithic material and only moderately strong on Neolithic material. Some indications of early work in copper and other natural metals appear to be present, but the Bronze technique is absent. In other words, the Iron Age followed directly on the Stone Age.

Asia, like Africa, has furnished at least some descriptions of fixed remains such as mounds, megalithic monuments and cave-wall art. Partly described surface collections ranging from the Lower Paleolithic upwards are also available from various localities, especially Mongolia; but most of our published information has until recently been derived from random excavations in sites representative of the Middle and Upper Paleolithic as well as of the Neolithic, Bronze and Iron Ages, with the Bronze Age apparently omitted in some places here as in Africa. Now, however, within the past ten years large collections have been delivered to us in orderly fashion from two of the thickest stratified deposits yet found anywhere in the world and which have yielded an abundance of both cultural and skeletal remains. One, a cave deposit in Palestine, measured over 70 feet in depth, and its cultural contents take us from historic times well back into the Lower Paleolithic stage. The other is a cave deposit near Peiping, China, which, judged by accompanying faunal remains, is regarded as dating back at least to the Middle Pleistocene. In addition, a culture stratum of similar age has been found elsewhere in North China in a geologic deposit no less than 180 feet below the soil surface. In view of all this, Asia's traditional claims to being the birthplace of man are much strengthened, a fact which has a direct bearing on our own problem of the antiquity of man in America.

Oceania must be dismissed with a mere glance. As already indicated, we have descriptions from certain northerly sections of this vast area of both ruins and monuments, as well as of surface collections of stone implements that by courtesy may be called archeological; but it is only the larger southern and western islands nearest the Asiatic mainland that in addition

have yielded clear indications of prolonged habitation. In Australia, for example, these as yet undated evidences are reported in the form of cave-wall art, shell-heaps of some size, seemingly primitive human cranial material and excavated rock-shelter culture deposits reaching as much as twenty feet in thickness. Thus far, however, it is the island of Java alone that has furnished both primitive skeletal remains and Lower Paleolithic stone implements of undoubted Pleistocene age.

The conclusions to be derived from this brief and superficial world survey must necessarily be very general. In view of the emphasis constantly placed upon *antiquity* and *cultural characteristics,* it is in order to suggest first of all that the evidence thus far recovered tends to confirm the long-prevailing view that man originated in the Old World in pre-Pleistocene times, that he reached the New World only after the last glacial retreat, when he was still a roaming hunter but in possession of a fully developed flintworking technique, and that he arrived in the eastern Pacific and other outlying archipelagoes relatively late, in fact in what for the continental regions were largely post-Neolithic times. Another safe conclusion is that our chronologically ordered discoveries have given us a fairly complete account of the evolution of the world's stoneworking processes, ranging from crude to highly skilled percussion flaking, through pressure chipping to pecking, grinding and polishing, thus giving us a clue not only to the technological but also to the relative time position of any given culture complex containing stone objects. We have learned also that the Three-Period system of Europe, embracing the Stone, Bronze and Iron Age sequence, does not apply uniformly to all places, especially in Africa and Asia. Last of all, in view of what is now known about the progress of material culture as a whole, it seems certain that the important economic shift from the original nomadic hunting or food-gathering existence to our present settled mode of life based chiefly upon agriculture took place first about midway in the great desert zone stretching from Morocco to Mongolia and that it was the result probably in part of the gradual desiccation and consequent food scarcity which followed the last glacial retreat. Just when this change, giving rise to division of labor and so by relatively swift steps to modern civilization, began is still uncertain, but present estimates vary all the way from 5500 to 18000 B.C.; and the truth doubtless lies somewhere between the two extremes.

FUTURE REQUIREMENTS

There remains to suggest briefly what prehistoric archeology has still to achieve in the field, in the museum and in the study. With so much actually accomplished what precisely is now lacking? The answers are many and varied. Thus far, naturally enough, the investigation has been mainly one of fact-finding, but even in this department there are important gaps in our knowledge and therefore doubtless serious defects in our interpretations. For instance, we do not yet know *when* or how far back in geologic time man and culture originated, whether in the Pliocene or the Miocene. Stated in another way, we need more light, for example, on the Eolithic problem; and this, indirectly, might well come from the New World, *i.e.,* from studies of flaked pebbles in corresponding Tertiary deposits, here supposedly long antedating the coming of man. We are equally ignorant as to *where* the decisive step first took place. Europe, Asia and Africa all present their special claims. Until these problems are settled we can not definitely say *how* or in what time order our two connected phenomena spread over the world, and in particular when or in what culture stage man first reached the American continent. Unanswered also are such secondary questions as to what became of the Neanderthal race and, more important still, from where did Cromagnon man or *Homo sapiens* suddenly arrive in western Europe? The field, in other words, obviously requires further investigation. We are in need, for example, of collections from many little-known areas such as the jungle, tundra and desert regions in various parts of the world. Collections are especially required from such strategic localities as northeastern Siberia, Alaska, the western plains of Canada, our own Great Basin and northern Mexico, to name only those nearest home. And, most important of all, we need stratigraphic work done in all but a few of our recognized culture areas throughout the world in order to establish first the relative and next the absolute chronologies that shall enable us finally to plot the place of origin and early movements of man and culture in visible form on the geologic column.

The archeological museum requires work in several different departments, such as the laboratory, the storerooms and the exhibition halls. In the laboratory, besides the improvement of normal routine, more study and experimental work are needed, for example, on the art of percussion flaking and pressure chipping in order that we may come to a fuller understanding of the varying degrees of expertness involved and so be better able to estimate the technological status of our individual specimens. In our storerooms, it is safe to say, is to be found a great deal of neglected work, in fact, neglected opportunities. Museums have hitherto been so exclusively intent upon exhibition facilities that they have given little thought to the adequate housing of study collections. As a result curators come and go at the larger museums, while immense

accumulations of costly specimens sometimes remain unnoticed. Probably much the same condition obtains with respect to most of the smaller collections, both public and private. The opportunity to enter the open field, even if previously investigated, is generally more inviting than the dusty attic. Nevertheless, it can hardly be denied that our fieldwork could be done more intelligently and more economically if we had our storage collections classified and arranged geographically, chronologically and typologically. More than that, it is only by complete familiarity, especially with our chipped stone material, that we are ever likely to become able to separate our intentionally designed implements from the merely accidental forms or to develop a really satisfactory classificational terminology. Stated in another way, the real advancement of our science depends much more upon what we do with our storage than upon what we do with our exhibits. However, in the museum proper we are actually confronted with a variety of more and more pressing problems. Hitherto we have offered the public for the most part only miscellaneous mass displays, astonishing enough perhaps as collections of meaningless curiosities but of little educational value. These exhibits, as our collections increase, must necessarily be condensed and simplified. Towards this end we should present chronological displays wherever possible, with typological subdivisions showing the order of appearance and general course of evolution of all the different arts and industries. For the culture areas lacking chronological determinations we might at least substitute synoptic exhibits with similar subdivisions for the various activities represented. Instructive also would be typological displays showing the complete geographic range of all the different inventions. Finally, we need to develop technological exhibits showing the normal order of gradual improvement of early man's skill in dealing with the various raw materials, such as stone, shell, bone, wood and fiber, skin, clay and the natural metals. In this connection the utilization of fire in the industrial processes, such as those of ceramics and metallurgy, would seem to need special emphasis, because it was this application alone that made modern industrial civilization possible.

We have finally to consider the study and the library. The requirements here also are twofold: those pertaining to the progress of the science of archeology itself and those pertaining to the education of the public. For the use of professional students, particularly in the United States and Canada, we need a complete bibliography, regional and subject, so that when any man or institution wishes to undertake a regional study or a piece of work in a given culture area it may be possible quickly to learn what has already been done in that particular field. Also we need an all-round good text-book on prehistoric archeology, an undertaking now almost beyond the capacity of any single scholar because before he can finish the last of his surveys the first is likely to be out of date. For more general use we need a new handbook in English for the American continent, somewhat like those long available for Europe. More especially we need a handbook for the United States and Canada, such as was begun by W. H. Holmes and the second and most important part of which lies perhaps partly finished. We need also for America, or at least for North America north of Mexico, an album illustrating all the principal forms of our antiquities. Such an album, with brief textual legends giving both time and space distribution for all incorporated inventions, might be patterned after that published for Europe by G. de Mortillet as long ago as 1881; but probably it would be more serviceable if its contents were arranged by industries, such as flaked and chipped stone, shellwork, bonework, woodwork, skinwork, basketry, textiles, ceramics and metallurgy. Additional topics might be included, as called for, relating to such skilled activities as hunting and fishing, agriculture and animal husbandry, medicine and surgery, quarrying and mining, architecture and engineering, decorative and pictorial arts, religious symbolism, and so on. The different sections might very well be issued separately to meet the varying demands which now exist. Such separates, provided with suitable general introductions, might even serve as popular guide leaflets to all the various basic arts and industries originated and developed by prehistoric man.

Summary and Conclusion

The attempt has been made in the foregoing paragraphs to outline the whole history of prehistoric archeology: its crude beginnings in ancient times, its steadily accelerating progress during the past two hundred years, and its present achievements. Special emphasis has been placed on the rôle played by the discovery of surviving primitive industries in America and elsewhere in bringing about a rational attitude towards Stone Age antiquities and a beginning of their systematic investigation. The creation and growth of the organization and personnel promoting and conducting this world-wide research must be left untouched except to say that to-day probably every civilized country has its museums and university teaching staffs. Public interest in man's prehistoric past was never greater than to-day and only financial support is necessary to afford opportunity for the increasing numbers of young men and women who are constantly pleading for a chance to take part in the work. Accordingly, though the task before us is still very great it is not so hopeless as in the case of some other

purely natural sciences like astronomy and entomology. For not only is the earth spherical and therefore limited in extent but man's period of occupancy is relatively short. In other words, while prehistoric archeology of necessity was one of the last special branches of research to get really under way, it is likely to be the first to finish its task. Indeed, if archeological investigations, historic and prehistoric, continue to progress at the same accelerating rate as in the past, it would seem that the next hundred years or so might easily see us in possession of all the essential facts. Those more or less indestructible facts or documents once in hand and the spade set aside, archeologists may have to change their titles to those of curators or something even less high-sounding. At all events, those professionally concerned may then devote their entire time to the permanent arrangement and final interpretation of all the available material culture traits, with a view to offering a visible demonstration of how, step by step from small beginnings, things as they are in the human world actually came to be so. That accomplished, when every one has become familiar with our recreated past, we shall be more nearly free and in the best possible position to give our whole-hearted attention to the really major creative problems of the present and the future.

HOW BREATHING BEGINS AT BIRTH[1]

By Professor YANDELL HENDERSON
LABORATORY OF APPLIED PHYSIOLOGY, YALE UNIVERSITY

ONE of the oldest problems of science is: Why does the baby begin to breathe at birth? The purpose is clear; but the cause and means are obscure.

Half an answer has long been available. It is well established that for many weeks or even months before birth the fetus makes distinct rhythmic respiratory movements. Ahlfeld[2] in 1915 published excellent graphic records of these movements. They were taken from the surface of the mother's abdomen. And a number of recent investigators have obtained moving pictures of respiratory movements in animal fetuses delivered by Cesarean section in a bath of warm saline.[3] But these movements are ineffective in expanding the lungs and keeping them expanded. The question then becomes: How are the feeble and ineffective respiratory movements of the fetus transformed into the effective breathing of the newborn?

The answer, I believe, is to be found in the fact that a certain function is deficient in the fetus; and that this function is quickly developed at birth and is then continually maintained throughout life. It is a function of critical importance alike for respiration, circulation and metabolism: the function of muscle tonus.

Many years ago I found that, when a man or animal dies, the muscles lose their tonus within five or ten minutes.[4] I was investigating various forms of manual artificial respiration. What I found was that only so long as tonus continues do the thoracic muscles and diaphragm retain a sufficient degree of elasticity to keep the lungs well expanded. And only so long as the lungs are thus held to a fair degree of expansion is manual artificial respiration effective. Pressure upon the chest, abdomen or back squeezes air out of the lungs. The inspirations that occur between compressions are produced wholly by the tonic elasticity of the victim's own muscles that pull the chest back to mid-expansion. After the body is entirely flaccid no form of manipulation can induce the slightest inspiration. When tonus is lost, the cubic capacity of the chest decreases and the lungs are correspondingly deflated. Even if the lungs are then inflated with a bellows, they deflate again as soon as the inflation is ended.[5] In normal breathing a large volume of air is held in the lungs even during expiration: the so-called stationary air.

The maintenance of a considerable volume of stationary air is extremely important. Unless the lungs are continually held in a sufficient degree of inflation, adequate aeration of the blood, either by artificial or by natural respiration, is impossible. Hess[6] has shown that even the movements of normal breathing may be regarded as essentially due to rhythmic variations in the degree of tonus in the respiratory muscles and particularly in the diaphragm. Extending this idea we may consider that the extent of the inflation

[1] Read before Connecticut Academy of Arts and Sciences, New Haven, Conn., December 10, 1936.

[2] F. Ahlfeld, *Monatsschr. f. Geburtsh. u. Gynäk.*, 21: 143, 1915.

[3] J. Barcroft, "The Brain in Its Environment," Yale University Press (in press).

[4] Y. Henderson, *Jour. Amer. Med. Assoc.*, Vol. 67: 1, 1916.

[5] The fact that no form of manual artificial respiration can directly induce an appreciable degree of inspiration affords no valid reason for the use of apparatus for artificial respiration. So long as tonus is present, manual methods are effective. When tonus disappears, the victim is dead beyond recall. Such apparatus as the pulmotor and others that apply suction to the lungs, promote, not recovery, but a further deflation of the lungs. For resuscitation in cases of atonic asphyxia of the newborn (*asphyxia pallida*) intratracheal insufflation is much more effective than any form of artificial respiration.

[6] W. R. Hess, "Die Regulierung der Atmung," Leipzig, 1931.

at which the lungs are normally held is a function of the tonus normally maintained in the respiratory muscles. The posture of the head and body in sitting or standing is well known to be dependent upon the maintenance of tonus in the muscles of the neck, back and legs. Similarly, the degree of inflation of the lungs that is maintained throughout life may be regarded as a posture dependent upon the tonus of the respiratory muscles. From birth to death the lungs are never deflated, because the diaphragm is never completely relaxed. For the development of effective pulmonary respiration at birth, tonus is essential.

The beginning of effective breathing may be aptly compared to the starting of an automobile. When the car is standing still, but with its engine running gently, we speak of its motor as "idling." And so it is with respiration before birth. The analogy may be carried even further. The baby that is born in asphyxia resembles a motor that is stalled. And as with the motor, so with the baby, a restoration of activity may be induced in two ways. The motor may be cranked and spun until, in spite of poor carburetion and ignition, a "cough" is induced. The baby likewise may be manhandled, as it formerly commonly was, until a reflex gasp is elicited. Or, on the contrary, in the car the carburetor and ignition may be adjusted until the motor starts at a touch. And in the baby the oxygen and carbon dioxide that its nervous system needs may be supplied by inhalation, as has now become the accepted practice; and resuscitation is thus effected without "cranking."

In such resuscitation it is not merely respiration that is involved.

Recently Oughterson, Greenberg, Searle and I[7] have produced evidence that muscle tonus normally plays a no less important and necessary part in the circulation of the blood. The slight pull that tonus maintains in all muscles even during relaxation induces a pressure between the muscle fibers like that produced between the strands of a rope under tension. This pressure prevents the blood from stagnating in the capillaries and promotes its flow into the veins and onward back to the heart. In the venous return muscle tonus plays an essential part. In the maintenance of the circulation the venopressor mechanism is second in importance only to the heart itself; for without the venous return the heart can not operate. The control of the venous return is exercised largely through muscle tonus by the motor centers in the spinal cord. It is distinct from the control of arterial pressure and the distribution of the arterial blood by the vasomotor, or sympathetic, nervous system. Cannon[8] has shown that, even after complete removal of the entire chain of sympathetic ganglia, animals (cats) may live in a fair degree of vigor. But, as I found 30 years ago,[9] when the venous return fails, the circulation stops; and as we have recently shown muscle tonus is an essential support for the venous return.

At birth the circulation undergoes a fundamental change. As the placental vessels contract, the blood is sent in full volume through the lungs. Previously the flow of blood back and forth between the fetus and the placenta has needed no support by muscle tonus. But at birth the circulation takes on a new vigor. The left side of the heart comes into action and arterial pressure rises to a higher level. For this adjustment a full venous return, induced and maintained by muscle tonus and intratissue pressure, is essential. This is shown by the fact that whenever, because of asphyxia during birth, tonus fails to develop, the flaccid baby exhibits the infantile form of shock, *asphyxia pallida*.

Before birth the fetus, floating in a fluid at body temperature, need produce little heat of its own. After birth the baby must assume the maintenance of its own heat supply to compensate for a continual loss of heat to a generally colder world. Normally the requirements of body temperature are soon met by the establishment of a basal metabolism sufficient to meet this requirement. And in the control of metabolism tonus plays a major part. The tonic pull of the muscles involves a consumption of oxygen, production of carbon dioxide and liberation of heat. And all these related functions are thus influenced by the nervous impulses from the motor centers in the spinal cord that chiefly induce tonus.

In respect then to the three vitally important functions of respiration, circulation and metabolism, the fetus has little need for tonus. But, if the baby is to establish and maintain its independent life, tonus is essential. In fact, the difference between the vigorous child and one that barely lives even in an incubator—the case of "Lebenschwäche" as the Germans term it—probably consists chiefly in the degree of their tonus. Even in the normal baby the lungs are dilated only gradually during the first day or two after birth. In the premature with a subnormal tonus the lungs may remain partially unexpanded for weeks. Along with the continuance of atelectasis the circulation is weak, metabolism and oxygen consumption low and heat production inadequate. Correspondingly the production of carbon dioxide is inadequate to produce full breathing; cyanosis develops; respiration is further depressed, and asphyxia ensues. Experience is showing that the most effective way to break this "vicious

[7] Y. Henderson, A. W. Oughterson, L. A. Greenberg and C. P. Searle, *Amer. Jour. Physiol.*, 114: 261, 1936.

[8] W. B. Cannon, *Amer. Jour. Physiol.*, 89: 84, 1929. Also "The Wisdom of the Body," New York, 1932.

[9] Y. Henderson, *Brit. Med. Jour.*, 2: 1872, 1906; and Y. Henderson and S. C. Harvey, *Amer. Jour. Physiol.*, 46: 533, 1918.

circle" is to stimulate an increase of tonus and deeper respiration by inhalation of carbon dioxide. Deeper respiration is the most effective means of inducing a better oxygenation of the blood; it is far more effective than inhalation of pure oxygen without deeper breathing. In the mixtures of oxygen and carbon dioxide now commonly used the carbon dioxide is the effective agent and the oxygen only a slightly better diluent than mere air.[10] A decisive demonstration of the life-saving value of the inhalational treatment of premature infants was afforded by Dr. A. R. Dafoe's success with the Dionne quintuplets.

But is it true that muscle tonus is practically absent in the fetus and develops at birth? The answer is afforded by observations made by D. H. Barron in Professor Barcroft's laboratory and reported by the latter[11] without, however, the full interpretation which I have here assigned to tonus.

The observations of Barcroft and his collaborators have been made chiefly upon sheep at various stages of gestation. The fetal lambs are delivered by Cesarean section and the placental circulation is maintained while the mother's body is immersed in a bath of warm saline. Under these conditions, as Barcroft reports, Barron has recorded the tonus of fetal lambs by means of the method described by Adrian for recording the electrical state of the muscles. "So long as the fetus is in its normal environment, or in a bath of warm saline, with the placental circulation unrestricted, the fetal muscles are entirely devoid of tonus. Take the fetus out of the saline and expose its skin to the air; tone at once appears in its muscles, only again to be abolished by replacing the embryo in the bath."

What tonus means for the beginning of life can be verified by noting the crucial part that this little noticed but fundamental function often plays in the end of life. The condition of physical depression that may follow serious physical injuries and major surgical operations—the state that in its extreme form is termed shock—has long been explained as due to fatigue, paralysis or some other form of failure of the control by the sympathetic nervous system over the vasomotor mechanism. A few investigators, including the writer, have refused to accept this conception; but until recently we failed to offer a wholly satisfactory alternative conception.

Now it is becoming clear that the depression lies, not in the sympathetic nervous system, but in the motor centers of the spinal cord; and that it results in such a depression of muscle tonus that respiratory metabolism and heat production are diminished, the blood stagnates in the tissues, the venous return to the heart fails, and the respiratory muscles relax until parts of the lungs are deflated.[12] Decisive experimental evidence for this conception of postoperative depression and shock is afforded by the fact that a condition in all respects like shock can be induced temporarily by spinal anesthesia. This occurs whenever the anesthetic reaches, not merely the sensory neurones for which it is intended, but the motor neurones that induce muscle tonus.[13]

To summarize: At birth the motor centers of the spinal cord come into action. By inducing tonus in the musculature of the body they increase metabolism and heat production, and render respiration effective. Without muscle tonus the blood would stagnate in the tissues and the circulation would fail. During life a high tonus is a feature of vigorous health. It is such tonus that enables the young soldier to stand long at attention. The elderly man of lessened tonus can not stand long without fatigue. The invalid may have sufficient tonus to permit him to sit, but not to stand. The patient with a low tonus and weak after operation or illness can scarcely hold his head up from the pillow. And, as death approaches, it is the failure of tonus that permits the major functions of respiration, circulation and metabolism to fail.

OBITUARY

MARSHALL AVERY HOWE

DR. MARSHALL AVERY HOWE, director of the New York Botanical Garden, died at his home in Pleasantville, New York, on December 24, 1936, in his seventieth year. Scion of an old Vermont family, he was born at Newfane, in the southern part of that state on June 6, 1867. In 1891, the year following his graduation from the University of Vermont, he went to the University of California as instructor of cryptogamic botany; there he remained for five years, devoting himself particularly to studies on hepatics and marine algae, the plant-groups which continued to hold his interest for the remainder of his life, although the algae received more of his attention than the hepatics in later years.

In 1896 he enrolled for graduate study at Columbia University, where he was a fellow in 1897–98, received the Ph.D. degree in the latter year, and remained as curator of the herbarium until 1901. At Columbia he was closely associated with those who

[10] Y. Henderson, SCIENCE, 83: 399, 1936.

[11] J. Barcroft, *Setchanov. Jour. Physiol.*, 4: 35, 1935; *Physiol. Rev.*, 16: 103, 1936; J. Barcroft and D. H. Barron, *Jour. Physiol*, 88: 56, 1936.

[12] Y. Henderson, *Bull. N. Y. Acad. Med.*, 11: 639, 1935; *Lancet*, July 27, 1935, p. 178.

[13] O. O. Schuberth, *Acta Chir. Scand.*, 78: Suppl. 43, 1936.

were engaged in the early development of the New York Botanical Garden, but it was not until the summer of 1901 that he was appointed to a position on the Garden staff, and relinquished his curatorship at the university. During that summer, accompanied by his brother, Clifton D. Howe, and another assistant, he spent some time in the botanical exploration of Nova Scotia and Newfoundland; collecting trips for marine algae in subsequent seasons took him to Florida, various parts of the West Indies and Panama.

He became assistant director of the New York Botanical Garden in 1923, and so continued until 1935. His directorship was from October 1, 1935, until his death less than fifteen months later; ill health for much of this period interfered with his duties in this office, yet his appointment as director was a fitting climax to his thirty-five years of faithful service in building up this great institution. In spite of his failing health the end came suddenly and unexpectedly.

He was a member of various scientific societies. Perhaps the earliest was the Chamisso Botanical Club, organized at the University of California early in 1891, a few months before his arrival there; of this society he was the third president. In the summer of 1895, while on a vacation in his home state, he was one of the six botanists who planned the Vermont Botanical Club, of which he became an original member when organization was effected. On January 12, 1897, soon after his arrival in New York, he was elected to active membership in the Torrey Botanical Club; the following year he was chosen an associate editor and was reelected annually thereafter, with the exception of the years 1908–10, when he was editor-in-chief of the *Bulletin* and *Memoirs* of the club. When the Torrey Club in 1901 added a smaller monthly, called *Torreya,* to its other publications, he was chosen editor of the new journal and so continued for seven years. At other times he was secretary and vice-president and he had been president for nearly a year at the time of his death.

In 1897, too, he became a member of the New York Academy of Sciences, and was soon thereafter elected a fellow of the academy. He was almost or quite continuously a member of the council from 1914, and was president in 1934 and 1935. His membership in the Botanical Society of America dated from 1899, and he was vice-president in 1913. The ballots for office in this society are cast by mail, and it was announced at the meeting a few weeks ago in Atlantic City that he had been duly elected president for the year 1937. This final honor, alas, came too late.

He was elected to membership in the American Association for the Advancement of Science in 1900, and became a fellow of the association in 1903. In 1907 he joined the Sullivant Moss Society, in 1911 the American Fern Society, in 1914 the American Society of Naturalists and within the few following years the Connecticut Botanical Society. In 1919 his alma mater, the University of Vermont, conferred upon him the honorary degree of Sc.D. And in 1923 he was chosen as a member of the National Academy of Sciences, an honor highly esteemed by most American scientists.

As a worker and as a writer he was extremely painstaking and conscientious. His contributions to botanical literature were numerous, and a few of them were sufficiently bulky to be regarded as books, although they all formed parts of serial publications. The earlier ones related chiefly to hepatics, the later ones to marine algae, but his interest in both groups was continuous throughout his career.

This brief outline of the life of Marshall Avery Howe furnishes unequivocal evidence of the high esteem of his fellow-workers. Those who knew him best respected him most, and his passing leaves his associates with a sense of profound loss.

J. H. Barnhart

RECENT DEATHS AND MEMORIALS

Cyrus R. Crosby, professor of entomology at Cornell University, died on January 11 on his arrival in Rochester for the annual meeting of the New York State Horticultural Society. He was fifty-eight years old.

Dr. Elias Hudson Bartley, professor of chemistry and pediatrics at Long Island College Hospital until his retirement with the title emeritus in 1931, died on January 12. He was eighty-seven years old.

Dr. Michael H. Corrigan, president of the Rhode Island College of Pharmacy and Allied Sciences, died on January 16 at the age of sixty-eight years.

Dr. Charles V. Noback, since 1926 veterinarian at the New York Zoological Park, died on January 16 at the age of forty-eight years.

Dr. William Henry Collins, consultant to the branch of mines and geology of the Department of Mines and Resources of Canada and acting director of the National Museum, formerly director of the Canadian Geological Survey, died on January 14 at the age of fifty-eight years.

Professor Robin Tillyard, an honorary fellow of Queen's College, Cambridge, chief entomologist of the Australian Commonwealth from 1928 to 1934, was killed in an automobile accident on January 13. He was fifty-five years old.

Dr. Bindo De Vecchi, professor of pathological anatomy and rector of the University of Florence, died on December 28 at the age of fifty-nine years.

A MEETING in commemoration of the late Dr. W. McKim Marriott was held at the Washington University School of Medicine, St. Louis, on January 3. The speakers included: Chancellor George R. Throop; Dr. Edwards A. Park, professor of medicine of the Johns Hopkins University School of Medicine; Dr. Alexis F. Hartmann, professor of pediatrics at Washington University, and Dr. Philip A. Shaffer, professor of biological chemistry and head of the department, Washington University School of Medicine.

SCIENTIFIC EVENTS

THE ANNUAL REPORT OF THE BRITISH MINISTRY OF HEALTH

THE annual report of the British Ministry of Health has been recently issued. The year 1935–36 was a period of outstanding health records. The death rate for infants under one year, at 57 per 1,000 births, and deaths from tuberculosis—fewer than 30,000—were the lowest on record. The maternal mortality rate, at 3.93 per 1,000 births, was the lowest since 1924.

According to a summary in the London *Times*, Sir Kingsley Wood, minister of health, said that:

Perhaps the important development in public health was that more and more they were not only seeking to prevent ill-health and disease, but were taking many measures to build up actively good health in the citizens, and adopting a positive policy which promoted directly healthy lives and living. In other words, they were concerned not only with prevention but with building. It was a policy of building up the citizen himself.

During the year over 250,000 expectant mothers had attended ante-natal clinics, and increased use had been made of infant welfare centers. But more must be done in regard to children between one and five years of age. Food was another factor of great importance. Nearly 150,000 samples of food and drugs were analyzed by public analysts during the year. It could be said that adulteration was disappearing, that the food supply was generally free from harmful ingredients, and that the customer was getting what he was entitled to get—good and wholesome food. As well as this, scientific investigation into the nourishment of the population was being carried on by the Advisory Committee on Nutrition.

The collection of family budgets, which is part of the Ministry of Labor's investigations into the cost of living, will provide much useful information about dietaries, but the Advisory Committee desired also that a number of quantitative dietary surveys should be carried out. I have asked local authorities to make these surveys, though the cost will, of course, be borne by the ministry.

A wonderful transformation had been worked in the water position by the £1,000,000 grant, and so far as our great industrial areas were concerned everything was perfectly satisfactory. There was now no danger of drought. Much more provision had been made for open spaces, parks, recreation grounds, playing fields and swimming pools. Loans sanctioned for these purposes during the last 12 months were some £2,300,000, and in addition nearly 250 acres of land for purposes of this kind were presented to the local authorities or to the National Playing Fields Association.

The work of preventing bad health must also be continuously pursued. This was particularly true in connection with housing. Already some 500,000 slum dwellers had gone to better, more decent homes. And every month now between 20,000 and 25,000 other slum dwellers were following them into these better conditions.

Smallpox has now been stamped out in this country. The one case in 1935 was the lowest recorded figure since 1918. They hoped to see more progress made against cancer, which was not yet defeated. Another "weak point in the armor" was maternal mortality, but there had been wonderful improvement in the last few years and steady improvement in the last 12 months.

THE NEW YORK BOTANICAL GARDEN

A REPORT of the past year's work of the New York Botanical Garden was presented on January 11 at the annual meeting of the board of managers by Dr. H. A. Gleason, deputy director, who is at present carrying on the work of Dr. Marshall A. Howe, who died on December 24.

According to his report, extensive reconstruction of Conservatory Range No. 1 on the west side of Bronx Park, commenced early this year, covering approximately two acres of ground, where thousands of exotic plants of decorative, botanical and economic interest are kept for public display, makes this conservatory one of the largest public greenhouses in the world. Its reconstruction—which will be carried out in such a way that at no time will the exhibits be sacrificed—will result in more effective showing of the collections.

The beauty of the grounds of the Botanical Garden will also be enhanced by more than a thousand trees and shrubs which were set out during the fall and by 800 young hemlocks which were added to the forest along the Bronx River. In the Thompson Memorial Rock Garden, one of the most frequently visited portions of the grounds, a bog area will be planted with special subjects this year and 7,000 heathers will be added to the heath planting. The new iris garden on the west side of the grounds will bloom for the first time this coming spring. Six thousand plants in 181 varieties comprise the collection.

Each member of the garden will receive, beginning this year, a subscription to *Addisonia,* which contains colored plates and descriptions of unusual plants. This will be in addition to the monthly *Journal* and the other privileges of membership.

A memorial resolution to the late Dr. Marshall A. Howe, director, was adopted by the board before the close of the meeting, as well as a resolution honoring Dr. Lewis Rutherfurd Morris, a member of the board who died toward the end of the year.

Henry W. De Forest, who has been president of the garden since 1928, was reelected, and Henry De Forest Baldwin was reelected vice-president.

ANNUAL REPORT OF THE SECRETARY OF THE SMITHSONIAN INSTITUTION

IN the annual report for 1936 of Dr. Charles G. Abbot, secretary of the Smithsonian Institution, which has now appeared, he points out that results have been especially encouraging in two fields—the correlation of solar radiation with the weather and the study of the effects of light on plant growth. One was the apparent proof that short-interval changes of the heat output of the sun, such as run their courses in a few days, are of major influence on the weather for the ensuing two weeks or more. Investigators of the U. S. Weather Bureau have agreed with him, Dr. Abbot reported, that investigation of this effect offers reasonable promise of a method of forecasting some features of the weather for two weeks or more in advance. Progress also was reported by Dr. Abbot in the development of his 23-year-cycle weather hypothesis. While much more work must be done in working out the details, he states that certain large and prolonged features, like the great drought in the Northwest, seem to be clearly predictable. Another development has been the working out of a sensitive and quick-acting spectroscopic method for measuring carbon dioxide in the air. By this method the respiration and carbon dioxide assimilation of a single grain of wheat in its germination is readily observed.

Nearly half a million specimens were added to the collections of the National Museum, mostly as gifts or from Smithsonian expeditions. One of these was the Richard K. Peck collection of ethnological material from the Negritos and Papuans of Dutch New Guinea, the Dyaks of Borneo and the Jivaro of Ecuador. In biology there was an accession of 465 mammals from Asia, Africa and South America, obtained by exchange with the Field Museum of Natural History. In geology a collection of Chilean minerals, including six new varieties, was obtained. The airplane *Winnie Mae,* flown by Post and Gatty around the world, was added to the arts and industries collection.

The Bureau of American Ethnology continued its researches at the recently discovered site of Folsom man in Colorado, the earliest known human settlement in North America. Archeological discoveries were made in Honduras by a joint Smithsonian-Peabody Museum expedition. A culture level was found that is apparently ancestral to that of the Maya. Among ethnological investigations were studies of the Timucua and the Indians of Hudson's Bay, Canada, the Mission Indians of California, the Shoshone, Bannock and Gosiute of Utah, Nevada and Idaho and the Iroquois of Canada.

The Smithsonian's International Exchange Service acts as the official United States agency for the exchange of scientific publications with foreign countries. During the past year this exchange involved the handling of over half a million packages.

At the National Zoological Park the outstanding event of the year was the beginning of construction of three new buildings under a grant from the Public Works Administration. These are a building for small mammals and great apes; one for elephants, rhinoceroses and hippopotamuses, and a new wing for the bird house. Over two million visitors went to the park during the year, including groups from 579 schools.

The Smithsonian Astrophysical Observatory continued to record the variations in the sun's heat at its three mountain stations, in California, Chile and Egypt. A new method of distinguishing unfavorable sky conditions was developed during the year, which will lead to even greater accuracy in measuring the sun's variability.

Besides the usual scientific publications, a weekly radio broadcast on the activities of the institution has been put on the air by the Office of Education in cooperation with the National Broadcasting Company.

THE CHARLES HAYDEN FOUNDATION

THE late Charles Hayden, of New York City, left his entire estate, estimated at about $50,000,000, with the exception of several specific bequests, to establish The Charles Hayden Foundation for the education of boys and young men and the advancement of their "moral, mental and physical well-being," and for other purposes.

A gift of $1,000,000 is made to his alma mater, the Massachusetts Institute of Technology, and outright bequests amounting to $647,000 to various friends. A trust fund of two million dollars is left to his brother, Josiah Willard Hayden, of Boston; a $500,000 trust fund to a friend, and three other small trusts for friends and employees are established. In each case the principal of these trusts reverts eventually to the foundation.

The objects of the foundation are given as follows:

1.—To assist needy boys and young men.

2.—To assist in charitable and public educational purposes for the moral, mental, physical and intellectual well-being, uplifting and upbuilding of boys and young men of this country.

3.—To found or provide scholarships for deserving boys and young men in this country, and for graduates or undergraduates of colleges, and to assist them in attending any educational institution in this country or abroad.

4.—To assist in or to found, equip and provide for the maintenance of institutions or associations for the advancement of learning in this country.

5.—To assist, build, equip and maintain gymnasia, clubs and recreation centers in this country for the training of boys and young men.

6.—To assist, and to receive, hold, administer and dispose of property to or for the benefit of any university, college, school or other institution for the advancement of learning or of any branch or department thereof, or for the benefit of any hospital or of any branch or department thereof.

Mr. Hayden placed no restrictions upon the use of the principal of his estate, but he did request that the greater part of the principle be so conserved that the benefits of the foundation might be extended to future generations.

"In the disposition of income and such principal as need be," he wrote, "preference shall be given to the furtherance of the foregoing objects within the City of New York and the City of Boston, but nothing contained herein shall be construed to prevent the aiding of such activities anywhere else in this country."

THE WASHINGTON AWARD

THE Washington Award Commission has voted to confer the 1937 award on Dr. Frederick Gardner Cottrell, of Washington, D. C., who was formerly director of the U. S. Bureau of Mines and director of the Fixed Nitrogen Laboratory of the U. S. Department of Agriculture. Dr. Cottrell is known for his work in helium production, in nitrogen fixation, for his processes of cleansing gases of dust and dirt by electrical precipitation and for research in petroleum technology. The award has been made for his "social vision in dedicating to the perpetuation of research the rewards of his achievements in science and engineering." He is the fourteenth American engineer to receive the award since it was founded in 1916 by John Watson Alvord, of Chicago.

The annual Washington Award, an honor conferred "on a brother engineer by his fellows for accomplishments which pre-eminently promote the happiness, comfort and well-being of humanity," is administered by the Western Society of Engineers in cooperation with the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. The tangible symbol of the award is a bronze plaque mounted in marble. This will be presented formally to Dr. Cottrell at a dinner on February 23.

Those who have received the Washington Award since its foundation are as follows:

1919—Herbert C. Hoover, "for his preeminent services in behalf of the public welfare."

1922—Robert W. Hunt, "for his pioneer work in the development of the steel industry and for a life devoted to the advancement of the engineering profession."

1923—Arthur N. Talbot, "for his life work as student and teacher, investigator and writer and for his enduring contribution to the science of engineering."

1925—Jonas Waldo Smith, "for the rare combination of vision, technical skill, administrative ability and courageous leadership in engineering."

1926—John Watson Alvord, "for his pioneer work in developing the fundamental principles of public utility valuation and his marked contributions to sanitary science."

1927—Orville Wright, "for fundamental scientific research and resultant successful airplane flight."

1928—Michael Idvorsky Pupin, "for devotion to scientific research leading to inventions which have materially aided the development of long-distance telephony and radio broadcasting."

1929—Bion Joseph Arnold, "for pioneering work in the engineering and economics of electrical transportation."

1930—Mortimer E. Cooley, "for vision and constructive leadership in the education of the engineer."

1931—Ralph Modjeska, "for his contribution to transportation through superior skill and courage in bridge design and construction."

1932—William David Coolidge, "for his scientific spirit and achievement in developing ductile tungsten and the modern x-ray tube."

1935—Ambrose Swasey, "for his distinguished contributions as a builder of instruments, institutions and men."

1936—Charles Franklin Kettering, "for his high achievements in guiding industrial research toward the greater comfort, happiness and safety of mankind in the home and on the highway."

THE AMERICAN SOCIETY OF CIVIL ENGINEERS

NEW officers of the American Society of Civil Engineers who take office at the eighty-fourth annual meeting of the society being held in New York from January 20 to 23 are as follows:

Louis C. Hill, consulting civil engineer, of Los Angeles, Calif., *president*, succeeding Dr. Daniel W. Mead, professor emeritus, hydraulic and sanitary engineering, University of Wisconsin; Commander Lyle F. Bellinger, U. S. Navy (retired), *vice-president*, succeeding Colonel D. H. Sawyer, Washington, D. C.; Roy C. Gowdy, Denver, *vice-president*, succeeding Professor Henry E. Riggs, University of Michigan. New directors are: Colonel William J. Shea and Enoch R. Needles, New York;

Arthur W. Dean, Boston, Mass.; Dean Roland P. Davis, College of Engineering, West Virginia University; T. Keith Legaré, Columbia, S. C., and Thomas E. Stanton, Jr., Sacramento, Calif.

Medals will be presented for distinguished work in the field of civil engineering as follows:

Dr. Arthur Newell Talbot, professor emeritus of engineering at the University of Illinois, the John Fritz Medal.

Dr. Daniel W. Mead, of Madison, Wis., the Norman Medal, for a report on the St. Lawrence water-power development.

Wilbur M. Wilson, research professor at the University of Illinois, the J. James R. Croes Prize, for the second best report.

A. V. Karpov, of the Aluminum Company of America, Pittsburgh, and R. L. Templin, chief test engineer of the same company, the Thomas Fitch Rowland Prize, for a report on construction work.

Paul Baumann, chief engineer of the Los Angeles County Flood Control district, the James Laurie Prize, for a report on sheetpile bulkheads.

Clinton Morse, of Balboa Heights, Canal Zone, the Collingwood Prize, for a report on engineering work.

Honorary membership will be conferred on Alex Dow, of Detroit; G. H. Duggen, of Montreal; Robert Hoffmann, of Cleveland; J. B. Lippincott, of Los Angeles, and J. A. L. Waddell, of New York.

SCIENTIFIC NOTES AND NEWS

FOLLOWING the Harvard Tercentenary the French Government conferred membership in the Legion of Honor with the rank of commander on President James Bryant Conant. Professor George D. Birkhoff, Professor Julian L. Coolidge, Professor James B. Munn and Jerome D. Green, director of the tercentenary, have been promoted from the rank of chevalier to that of officer of the legion. The rank of chevalier has been conferred on Professors Bliss Perry, Edward B. Hill, Edward W. Forbes, Roger Bigelow Merriman, Ralph Barton Perry, Edward A. Whitney, Kenneth J. Conant and George Harold Edgell.

DR. CUSTIS LEE HALL, assistant professor of orthopedic surgery in the George Washington University School of Medicine, Washington, D. C., was presented on January 4 with the first Citizens' Service Award for 1936. The cup, which will be awarded annually to the citizen who is considered to have rendered the most unselfish service to the whole community, is provided by the Washington *Times;* the recipient is selected by a representative citizens' committee. Dr. Hall was chosen for his work among crippled children and adults.

THE $1,000 prize and bronze medal of Eli Lilly and Company was presented on December 29 at the Indianapolis meeting of the Society of American Bacteriologists to Dr. Harry Eagle, of the Johns Hopkins Hospital, for research on immunity to various diseases, notably syphilis. The prize is awarded by a committee of the Society of American Bacteriologists, the American Association of Immunologists and the American Society for Experimental Pathology.

DR. LEROY M. S. MINER, dean of the Harvard Dental School and president of the American Dental Association, received a medallion "in recognition of outstanding service of benefit to dentistry during the past year" at the annual convention of the dental fraternity, Alpha Omega, held in Boston from December 29 to 31.

GEORGE DAVID OBERLE has been awarded the annual research prize of the Kansas State College Chapter of the Society of Sigma Xi for his work on "The Influence of Leaf to Fruit Ratios on the Photosynthetic Activity of York and Livland Apple Leaves." This prize is awarded annually by the society to a graduate student at Kansas State College who makes the most significant scientific contribution during the year.

THE Melchett Medal of the Institute of Fuel, London, has been awarded to Dr. Franz Fischer, director of the Kaiser Wilhelm Institute for Coal Research.

JAMES G. K. MCCLURE, JR., of Asheville, N. C., has been elected president of the American Forestry Association, succeeding Dr. Henry S. Graves, dean of the Yale Forest School and formerly chief of the Forest Service, who retired on December 31. At the same time the association announced the election of four new directors: Karl T. Frederick, of New York, president of the New York State Conservation Council, to serve for five years; Joseph H. Pratt, of Washington, D. C., formerly president of the Southern Forestry Congress, to serve for two years; Wilbur K. Thomas, of Philadelphia, executive secretary of the Carl Schurz Memorial Foundation, to serve for two years; and Wallace W. Atwood, president of Clark University and formerly president of the National Parks Association, to serve for one year. Dr. Graves was elected to serve as a director for a period of five years, and Dr. John C. Merriam, president of the Carnegie Institution of Washington, was reelected to serve for a five-year period.

DR. RAYMOND W. WAGGONER, associate professor of neurology at the University of Michigan Medical School, who was recently made director of the State Psychopathic Hospital, has been promoted to a pro-

fessorship and has been made director of the department of psychiatry.

A SHELDON traveling fellowship in geology has been awarded by Harvard University to Fred B. Phleger, Jr., of Glendale, Calif., a graduate of the University of Southern California and of the California Institute of Technology.

THE departments of botany of Cornell University and of the Ohio State University have arranged an exchange of instructors for the spring term of the current academic year. Dr. E. M. Palmquist, of Cornell University, and Dr. C. E. Taft, of the Ohio State University, have been selected for the exchange. Both instructors will be engaged in the teaching of general botany in the large elementary courses.

DR. LAWRENCE GAHAGAN has resigned from an assistant professorship of psychology in the University of California at Los Angeles in order to take up the study of medicine.

DR. LANCELOT HOGBEN, professor of social biology in the University of London, has been appointed Regius professor of natural history in the University of Aberdeen in place of Professor James Ritchie, who has resigned.

DR. JOHN ALFRED RYLE, Regius professor of physic in the University of Cambridge, has been elected to a professorial fellowship at Gonville and Caius College.

DR. WILLIAM BOWIE, chief of the division of geodesy of the U. S. Coast and Geodetic Survey, who will be sixty-five years old next May, has retired. He joined the survey in 1895 as a field engineer.

DR. ALONZO E. TAYLOR, director of the Food Research Institute at Stanford University since 1921, has been appointed chairman of the research committee of General Mills, Inc., Minneapolis.

DR. MORLEY A. JULL, head of the poultry department of the University of Maryland, has been elected secretary of the Industry Committee of the seventh triennial World's Poultry Congress, that will be held for the first time in the United States in 1939.

PRESIDENT ROOSEVELT sent to the Senate on January 11 the nomination of Charles Edison, of New Jersey, son of Thomas A. Edison, to be Assistant Secretary of the Navy.

FRANK A. ARNOLD has been appointed managing director of the Technical Press of the RCA Institutes, Inc. He will direct the publication of the *RCA Review*, a quarterly journal of radio progress.

DR. JOHN H. GEROULD, who is on leave of absence from Dartmouth College, will be at the Imperial College of Tropical Agriculture, Trinidad, from February 7 until April 15, 1937.

LLEWELYN WILLIAMS, assistant curator of economic botany at the Field Museum, Chicago, left early in January on an expedition of several months in southern Mexico to obtain general botanical collections for the museum. The expedition was made possible through cooperation extended by F. J. Riker, president of Maderas Tropicales, South America, a division of the Ozark Corporation, Detroit. Work will be concentrated on the Isthmus of Tehuantepec, especially in the region of Minatitlan, in the state of Vera Cruz.

SIR HUBERT WILKINS, the Arctic explorer, returned to England, after visiting the United States, on January 3. He hopes to raise £10,000 there to complete the sum needed to construct the submarine in which he intends to cross the Arctic under the ice. He has already received the sum of £25,000 towards the cost.

MISS L. E. CHEESMAN has returned to England after a year's absence, during which she made a collecting expedition to Dutch New Guinea to obtain specimens for a research into the insect fauna of the Cyclops Mountains and to collect scientific material for the British Museum of Natural History.

THE Gehrmann lectures of the College of Medicine of the University of Illinois will be delivered on January 25, 26 and 27 by Dr. Thomas Parran, Surgeon General, U. S. Public Health Service. The subjects of the individual lectures are: "Health as a Factor in Social Security," "Industrial Hygiene" and "Syphilis."

DR. ELMER V. MCCOLLUM, professor and head of the department of biochemistry at the Johns Hopkins University School of Hygiene and Public Health, will deliver at Detroit on February 15 and 16 the annual Beaumont Lectures of the Wayne County Medical Society. His subject is "Recent Advances in the Field of Nutritional Research."

THE address at the fall initiation meeting of the Ohio State University Chapter of the Society of the Sigma Xi was on December 7 delivered by Dr. Laurence H. Snyder, professor of zoology. His subject was "Questions and Answers."

THE two hundred and twelfth regular meeting of the American Physical Society will be held on Friday and Saturday, February 19 and 20, at Chapel Hill and Durham, N. C., in affiliation with the Southeastern Section of the American Physical Society and the American Association of Physics Teachers. Other meetings for the current season are as follows: Washington, D. C., April 29 to May 1; Pacific Coast, time and place not yet decided; Madison, Wis., June 22 and 23.

AN International Congress on Hepatic Insufficiency and Liver Diseases is to be held at Vichy, France, on

September 16, 17 and 18. Dr. Anthony Bassler is the chairman of the American committee of the congress. The American group will present papers on "The Relation of Hepatic Insufficiency to General Nutrition and Especially to the Nervous System." Those taking part are Dr. Anthony Bassler, New York; Dr. Hyman I. Goldstein, Camden, N. J.; Dr. Andrew C. Ivy, professor of physiology and pharmacology, Northwestern University Medical School; Dr. Lathan A. Crandall, Jr., Chicago, and Dr. Norman W. Elton, Reading, Pa. This congress will follow the second International Congress on Gastroenterology, which meets at Paris on September 13, 14 and 15.

A UNITED PRESS dispatch from Moscow reports that three hundred and sixty-nine foreign geologists, representing forty-six countries, have signified a desire to participate in the International Congress of Geology to be held in Moscow this summer. Most of the participants—one hundred and thirty-six—will go from the United States. The desire to attend was reported also by thirty-three English, twenty-six French, twenty German and sixteen Spanish geologists and by a number of geologists from Italy, Switzerland and other countries. It is reported that the program will include a hundred and fifty papers by foreigners and about two hundred and fifty papers by Russian geologists.

THE fourth International Grassland Congress will be held in Great Britain in July under the presidency of Professor R. G. Stapledon, director of the Welsh Plant Breeding Station and the Imperial Bureau for Herbage Plants, Aberystwyth. Delegates will attend from Great Britain, the British Dominions and Colonies, the United States and numerous other countries. The paper-reading sessions will be held in Aberystwyth from July 13 to 19, but participants will be able to join in a tour of centers of grassland interest and selected farms both before and after these sessions. Delegates will be able to choose one of a number of options to take part in the whole congress or certain sections of it. Special addresses will be given on certain evenings at Oxford, Cirencester, Aberystwyth and Newcastle. The paper-reading sessions to be held in Aberystwyth will be divided into three plenary and two sectionalized sessions. The latter will deal with numerous aspects of the grassland problem, including ecology, pasture and range management, seed mixtures, plant breeding, genetics and seed production, manures and fertilizers, nutritive value of pastures, fodder conservation and grassland economics.

THE first International Conference on Fever Therapy will be held at Columbia University College of Physicians and Surgeons, New York, from March 29 to 31. The program is divided into four parts with committees in charge as follows: physiology, pathology and methods of production of fever, Drs. Frank W. Hartman, Detroit, *chairman,* and Charles A. Doan, Columbus, Ohio, *secretary of the committee;* miscellaneous diseases treated by fever therapy, Drs. Clarence A. Neymann, Chicago, *chairman,* and Frank H. Krusen, Rochester, Minn., *secretary;* syphilis, Drs. Walter M. Simpson, Dayton, Ohio, *chairman,* and Leland E. Hinsie, New York, *secretary;* gonorrhea, Drs. Stafford L. Warren, *chairman,* and Charles M. Carpenter, *secretary,* Rochester, N. Y.

AN exhibit from the Carnegie Institution of Washington was opened at the Museum of Science and Industry, New York City, on the evening of January 14, with a preview for trustees of the museum, scientific men, engineers and other invited guests. The exhibition shows among other things research in the exploration of the earth's high atmosphere with radio waves; the present-day Maya Indians of Yucatan; pinocytosis, the drinking of fluids by cells; the march of forests in response to changing climate; new factors in animal metabolism, the formation of copper ores, etc. There will be moving exhibits, motion pictures, lectures, transparencies, etc.

THE Museum of Natural History of Syracuse University, containing large and valuable scientific collections, was destroyed by fire which swept the top floor of Lyman Hall, housing the university's natural science laboratories, on January 1. The damage is estimated at $450,000. The fire first was observed in the office of Dr. Ernest Reed, head of the department of botany, who is in Venezuela on a scientific expedition. In the museum were specimens of the university's first Andean expedition, including stuffed animals, rocks and geological specimens; collections from Venezuelan expeditions; fifty or more rare plants as yet unidentified; a collection of Mayan and Aztec idols; the university collection of African mammal horns, valued at $2,000, a recent purchase; a collection of minerals, valued at $20,000; complete "file" of mounted birds of this locality; a set of miniature African mammals from the American Museum of Natural History; a collection of carved pieces of South Sea Island ivory; taxidermy equipment, microscopes and stereopticon slides; letter and manuscript files; a collection of shells; an "almost priceless" collection of first editions describing the natural history of New York State; three large skeletons of extinct reptiles.

AT the annual meeting held at Atlantic City on December 30, 1936, the Genetics Society of America passed the following resolution: "The Genetics Society of America records its regret that it appears impossible to hold the meeting of the Seventh International Congress of Genetics in the summer of 1937 as

planned; and in view of the importance of maintaining friendly contact among the geneticists of all countries through regular international congresses it urges that the International Committee arrange for holding the Seventh International Congress at the earliest practicable time."

DISCUSSION

THE SAN DIEGAN ALLIGATOR LIZARD AND THE BLACK WIDOW SPIDER

TOWARD the end of 1935, or early in 1936, local newspapers carried several accounts of a contemplated introduction of *Bufo marinus* to California, to act as a biological control of the black widow spider, *Latrodectus mactans*. That such an attempt might actually be made seems possible, owing to the scare notices which periodically appear in California, claiming that this dangerous spider is on the increase.

While considering the feasibility of introducing this toad and the dangers attendant upon such a procedure, it seems proper to visualize it and its manners of attacking a spider. To one knowing something of the habits of the black widow, such a contemplation conjures up a picture of a robust toad squeezing into cracks under boards and stones, crawling up the studding in garages and homes, clambering into dense shrubs and hedges, leaping nimbly into the air to pick the spiders from the center of their webs, and in other ways behaving in a manner not at all compatible with bufonid temperaments and capabilities. The few spiders found wandering about on the grounds and accessible to the toads would be so small in number as to form only an inconsiderable percentage of the whole population.

After giving some study to the problem of a possible native predator it appeared highly probable that the habits of the San Diegan alligator lizard, *Gerrhonotus multicarinatus webbii*, in southern California, and other subspecies elsewhere in the state, would bring this reptile into close contact with the spiders. This lizard, on close study, also appeared to be the only animal with a habitat approximating that of the black widow.

It was hoped that a study of stomach content might furnish evidence in support of the theory that the lizard is an important predator on the spiders, but it is obvious that only by very remote chance would one find even the chelicerae in the digestive tract of the lizard. Adult spiders, in spite of all the alarms, are too scarce to form an important element in the diet of *Gerrhonotus*.

Although studies in food habits carried on with captive specimens are, or should be, considered subject to serious questioning (as witness our desert tortoise, *Gopherus agassizii*, eating cheese, apples, bananas and lettuce in captivity), in this case, the method appeared our only hope of obtaining any light on the problems under scrutiny.

Although more work on this problem will be undertaken during the coming year, it is not believed that anything but confirmation of our initial results will be forthcoming. In the early attempts, it was found that the female spiders of any size were eagerly consumed by *Gerrhonotus*, and that all healthy and active specimens fed readily. This, in itself, might not be significant, but in view of the repeatedly observed response of the lizard to the egg sacs of the spider, it is believed that this lizard may be the chief vertebrate enemy of the black widow. Every egg sac, whether containing eggs or young, when placed in the lizard's cage, was consumed. The lizard often showed an almost immediate response to the presence of such an inanimate object and would swallow the entire sac as well as the contents. Such behavior is particularly significant to any one who is familiar with these lizards, since they will be aware that this species is ordinarily responsive only to moving objects and that this feeding habit is therefore particularly significant. After conducting the feeding experiments with *Gerrhonotus*, a specimen of *Sceloporus occidentalis biseriatus* was given an opportunity to feed, and the spider was taken with great readiness. It is probable that many other species of lizards would likewise do so, but it is highly improbable that any of them would be as important an enemy of the spider as *Gerrhonotus*, owing to the fact that none of them fits as neatly into the requisite habitat. It is only a remote chance that our other species of lizards would figure as controls of the black widow.

As has been previously stated, it is commonly reported that the black widow spider is on the increase in southern California, and there has been much informal discussion of the subject. That there has been a total increase is entirely probable, since every new building, at least those erected in open country, should furnish more sanctuary than would the same area without a house. Most of the claimants for the increasing abundance theory seem to believe that there has been not only a general increase, but an actual increase in the density of the population within the habitat as well as in total numbers.

Since there are no population counts compiled at any time in the past, there can be no satisfactory method of comparing conditions of ten or twenty years ago with the present; therefore, there can be no solution to this phase of the problem. Theoretically, however, any decrease in the number of parasites and predators would result in an increase in the density of population, irrespective of increase in available areas. If there has been no decrease in parasite effectiveness, but if there has been a reduction in the number of effective predators, we would expect that there might be an actual temporary increase in the density of the spider population, which would continue until the additional food supply made available to the parasite would act on the population of these organisms, accelerating their rate of increase to meet the newly created opportunity for multiplication. That we may be in a stage where there are more spiders available and where the parasites have not yet increased to their maximum numbers seems entirely possible.

So far as one may judge, all gardeners, amateur and professional, are 99.9 per cent. antagonistic to all reptiles, and the unfortunately snake-like *Gerrhonotus* is apparently particularly obnoxious to these active outdoor people. Although the above percentage may not be exact, at least one seldom hears of any evidence indicating a friendly attitude on the part of the non-herpetologist to this lizard. Unfortunately, even though the gardeners might be amenable to a herpetological conversion, the clean, cultural methods involved in gardening and cultivation of the ground are both inimical to an increase in the number of lizards. Another factor which may have a bearing on numbers of these useful animals is the predatory skill of our domestic cat. Although our spiders are so much feared and although the lizards may be an important control device, it is not believed that even though this information is disseminated there will be any marked shift in the choice of pets, at least not on the part of those who, at least since Darwin's time, have enjoyed the company of cats. In the writer's own experience, cats are serious enemies of this as well as other species of lizards. Again, in the writer's experience, it appears to be probable that the protection and introduction of *Gerrhonotus* will result in a decreasing population of the black widow spider. Too many uncontrolled factors enter into the present discussion, but it might be mentioned here that five years ago the writer's house was thoroughly popular with black widow spiders. An effort to reduce their numbers made little impression on the population. At the same time, however, an effort was being made to increase the numbers of the San Diegan alligator lizard. Individuals of this species were introduced onto the place; cats were carefully driven away; and clean cultural methods were not employed. As a result, the population of the alligator lizard increased considerably. Five years later, when spiders were needed for the present experiment, it was found that the black widow was extremely scarce; hardly any specimens could be found on the writer's property. That this may have been due to an increase in the number of parasites is recognized; but it may also have been due to the presence of an unusually large number of *Gerrhonotus*. Particularly significant is the fact that in the garage, where spiders were particularly abundant, *Gerrhonotus* was repeatedly found climbing about within the building, even as high as the top of the garage door, approximately eight feet from the ground. Here the lizard would lie in the narrow space between the top of the door and the lintel, where occasionally they were crushed by the closing of the doors. Although the evidence in this case is circumstantial, it appears probable that the friendly protection and encouragement of the San Diegan alligator lizard and, incidentally, the elimination of cats, might be of considerable benefit to the population of southern California.

RAYMOND B. COWLES
UNIVERSITY OF CALIFORNIA
AT LOS ANGELES

NOTES ON THE DISTRIBUTION OF THE BLACK WIDOW SPIDER

IN Donald C. Lowrie's note in SCIENCE for November 13, 1936, "New Localities for the Black Widow Spider," Minnesota, Iowa, Virginia, Delaware, New Jersey, Connecticut, Rhode Island and Vermont are listed as the only states from which this spider has not been officially recorded.

However, it may be noted that this spider must be fairly prevalent all over the state of Virginia, as stated by G. W. Jeffers in SCIENCE for December 11, 1936, and has been recorded by Anderson and Walker,[1] C. R. Willey[2] and W. J. Schoene,[3] as well as noted in the article by C. E. Burt in the *Journal* of the Kansas Entomological Society (8: 4, 117, 1935).

In addition this spider has been recorded from New Jersey by C. H. Headlee[4] in 1935, from Connecticut by W. E. Britton[5] in 1935 and from Rhode Island by A. E. Stene[6] in 1936.

H. L. Bailey informs me that this spider has been collected in Springfield, Vermont, in the fall of 1936 (identification verified by C. R. Crosby, of Cornell

[1] L. D. Anderson and H. G. Walker, *Bulletin*, U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, Insect Pest Survey, 12: 404, 1932.
[2] C. R. Willey, *ibid.*, 14: 9, 296, 1934.
[3] W. J. Schoene, *ibid.*, 15: 7, 359, 1935.
[4] C. H. Headlee, *ibid.*, 15: 8, 389, 1935.
[5] W. E. Britton, *ibid.*, 15: 6, 318, 1935.
[6] A. E. Stene, *ibid.*, 16: 6, 306, 1936.

University). Also Paul L. Rice, of the Delaware Agricultural Experiment Station, states that he and Donald MacCreary have frequently observed this spider near Camden and Wilmington in the fall of 1936.

Letters from Clarence E. Mickel, of Minnesota, and C. J. Drake and H. E. Jaques, of Iowa, report that they have no records of this spider having been found in their states, but that it probably occurs there. Thus Minnesota and Iowa are the only states from which this spider had not been recorded.

L. D. ANDERSON
H. G. WALKER
VIRGINIA TRUCK EXPERIMENT STATION
NORFOLK, VA.

WESTERN HIGHWAY HAZARD FOR JACK RABBITS

WHILE passing over the highways of Idaho one is usually impressed by the great number of jack rabbits which have been killed by automobiles. On November 17, 1936, the writers passed through the Hagerman Valley, where dead jack rabbits were especially numerous along the highway, and a count of dead rabbits the following day showed that 154 had been killed by automobiles in three tenths of a mile. It was evident that they had been killed within a few days, as otherwise they would have been devoured by the scavenger crows and magpies.

At the point where the count was made, there was a stack of alfalfa hay in a small alfalfa field on one side of the road, while on the other side sagebrush extended back for miles. The fall weather had been unusually dry, so there was no green vegetation amongst the sagebrush. It therefore appears that at this place the jack rabbits had been attracted to the alfalfa and had subsequently met their death.

A. O. LARSON
D. E. FOX
BUREAU OF ENTOMOLOGY AND
PLANT QUARANTINE
U. S. DEPARTMENT OF AGRICULTURE

PROTECT DIONAEA MUSCIPULA

Dionaea muscipula Ellis or Venus fly-trap is not only one of the most interesting biological objects but is also a plant species that is strongly endemic. It has been reported from the environment of Wilmington, N. C., and from a few localities in South Carolina.

I was frequently able to visit this region, especially around Wilmington. In many places here this plant has become extinct. In fact, during the last three years I was able to witness the disappearance of plants over several fields. An important reason for its disappearance is that a considerable part of its natural habitation is being artificially drained to aid agriculture, the result being that we find on the remaining land another type of vegetation which threatens the existence of *Dionaea* very distinctly, whereas, in other places, we observe a modification of plant associations, although *Dionaea* still remains.

It would be very desirable that some typical parts of that interesting country should be protected before it is too late. The land of that neighborhood is cheap. Its purchase by state or government would offer no objections.

J. C. TH. UPHOF
ORLANDO, FLA.

CUSCUTA NOT A COMPLETE PARASITE

Too often, when a false statement creeps into a book, it is copied and passed along. Thus it is, again and again, when a new text on botany appears, once more appears the statement that Cuscuta is a complete parasite devoid of chlorophyll. Though I make no claim to having read every American text-book on botany, I believe I have seen the majority of them, and with no exception, these state that cuscuta is devoid of chlorophyll.

Dodder is a phanerogam, Convolvulaceae. Its seed germinates somewhat differently from others of that family, for it sends forth a green (protonema-like) filament, which runs over the surface of the ground, drying at the seed end as it grows, until it reaches a succulent host, whereon it twines and forms haustoria. Then its stems become somewhat brownish, but the areas where haustoria are functional are still quite green. In midsummer it blooms. Its buds also are quite green, its fruits very green.

Alcoholic and ether extracts would show that the fruits have as much chlorophyll as any other convolvulaceous plant, its buds nearly as much, its haustellate areas about half as much and other parts of the stem a little. Inasmuch as plants with little chlorophyll produce more carbohydrate per unit than those with much chlorophyll, it is quite likely that Cuscuta may be able to sustain itself on its own organic foods, as does mistletoe. Let some physiologist solve that problem.

Dr. Louis Knudson in a personal conversation stated he had grown dodder on nutrient agar unsuccessfully unless a green host plant was supplied. He admitted, however, other factors might be involved.

Cassytha (Lauraceae), often mistaken for Cuscuta, has about the same relative distribution of chlorophyll. Cuscuta and Cassytha are green plants, even though they are parasites. They do contain chlorophyll, both alpha and beta. Strasburger states they have chlorophyll.

F. A. VARRELMAN
NEW YORK BOTANICAL GARDEN

REPORTS

ACTIVITIES OF THE COMMONWEALTH FUND

In its annual report for the year ending September 30, 1936, made public on January 18, the Commonwealth Fund records appropriations amounting to $1,967,153.26, intended, in the words of its founder, Mrs. Stephen V. Harkness, "to do something for the welfare of mankind."

More than two thirds of the total was devoted to the betterment of health. Grants were made for public health service to rural communities, rural hospitals, medical education and medical research. Postgraduate education in medicine was emphasized, the fund believing that such work is of major importance in improving the quality of medical service.

For the first time in several years a large share of these appropriations went to educational institutions in New York City. The largest of these was a conditional gift of $250,000 to the College of Physicians and Surgeons of Columbia University, to meet part of the cost of enlarging laboratory facilities at the Columbia-Presbyterian Medical Center for graduate teaching in the medical specialties. The fund also continued to help in financing a study, sponsored by the New York Academy of Medicine, of medical education in New York hospitals.

As part of its mental hygiene program the fund contributed to educational activities at the Babies Hospital and the New York Hospital. A similar project at the Children's Hospital in Boston is also being supported by the fund.

The fund continued to work through various channels for the improvement of medical practice in rural areas, particularly in Tennessee, Mississippi and the northern New England states. In all, 379 scholarships have now been awarded to physicians for postgraduate study at Harvard, Tulane, Vanderbilt and other medical schools.

In the belief that improvement in rural medical service will be hastened if newly trained physicians enter practice in country districts, the fund offers scholarships to undergraduates in medicine at Tulane, Vanderbilt and Tufts. Thirty-nine scholarship holders have now been graduated and seven have completed their internships and have entered practice, in accordance with the terms of the grant, in towns of less than 5,000. Twelve or more well-trained young physicians will be ready for rural practice each year in the three states, Mississippi, Tennessee and Massachusetts, where these scholarships are offered.

Nine years ago the fund began to build, with local cooperation, small general hospitals in country communities. After six had been completed, the depression interrupted the building program, but this has now been resumed. The seventh hospital, in Kingsport, Tennessee, has been open a year and more than 5,000 persons in a population of approximately 21,000 have already subscribed to a prepayment plan entitling the subscriber to free hospital care or a discount on hospital charges. An eighth hospital is nearing completion in Tupelo, Mississippi, and a ninth has been awarded to Ada, Oklahoma.

During the past year state health department service has been emphasized as the best means of improving local health work. In Tennessee, Mississippi and Massachusetts traveling units have worked under state auspices to supervise and strengthen local health departments or to deal with particular health problems such as communicable disease and tuberculosis. The fund has also helped to finance the development of health departments in two counties in Tennessee, two counties in Mississippi and two town-unions in Massachusetts. These areas are used as demonstration and training centers. In New Mexico the fund has continued to help spread nursing service over the state.

The fund made its first appropriation during the year to a newly organized study of high blood pressure uncomplicated by organic disease, to be directed by Dr. Warfield T. Longcope at the Johns Hopkins University School of Medicine.

Continued appropriations were made for the study of placental extract in the treatment of measles and other virus infections at the Harvard Medical School, of trachoma at Washington University, of rheumatic fever at the New York Hospital and the House of the Good Samaritan, Boston, of tuberculosis at Bellevue Hospital, New York, and at the Harriet Lane Home of the Johns Hopkins University School of Medicine, of kidney function at the University of Pennsylvania, of the chemical nature of insulin at the Johns Hopkins University and of growth and development in childhood at the University of Colorado.

Aid was given to the study of the structure and development of the brain at the Neurological Institute, New York. The fund continued to share in the fight against pneumonia by subsidizing the serum treatment project of the New York State Department of Health, by aiding the Michigan State Department of Health to study special reactions connected with serum treatment and by publishing a handbook for physicians on the serum treatment of this disease.

The legal research committee, headed by George Welwood Murray, sponsored studies in administrative law and legal history.

The fund continued to offer a group of fellowships for British graduate students at American universities, 31 having been appointed this year to spend two years in this country as guests of the fund. The distinguished physicist, William Lawrence Bragg, of the University of Manchester, has been elected to the British Committee of Award which selects these fellows, succeeding Sir Hector Hetherington, vice-chancellor of the University of Glasgow.

Appropriations were made for the training of psychiatrists and psychiatric social workers as a contribution to the progress of mental hygiene in the United States. The fund shared in the support of a central bureau of information about child guidance, under the auspices of the National Committee for Mental Hygiene, and of a study of psychiatric education. Gifts were made to the Welfare Council and to the Family Welfare Committee of New York City.

At the close of the fiscal year, September 30, 1936, the invested assets of the fund had a book value of $42,607,226.31 and a market value of $41,039,182.93. The directors of the fund are as follows: Edward S. Harkness, president; Malcolm P. Aldrich, Samuel H. Fisher, William M. Kingsley, Robert A. Lovett, George Welwood Murray and Dean Sage.

SPECIAL ARTICLES

A CRYSTALLINE VITAMIN A CONCENTRATE

THE non-saponifiable matter from the liver oil of *Stereolepis ishinagi*[1] was dissolved in a suitable solvent and fractionated by freezing at carbon dioxide snow temperatures. A final product, quite distinctly crystalline to the naked eye, was obtained. This material had the rather remarkable value of $E^{1\%}_{1\,cm} = 2{,}000$ (as determined by the Hilger Vitameter-A) while the blue value (determined by antimony trichloride reaction according to the method recommended by the British Pharmacopoeia) was 100,000. It is interesting to note that the ratio between these values is 1 to 50, which is in agreement with the ratio of the rather generally accepted provisional standard values for vitamin A, $E^{1\%}_{1\,cm} = 1{,}600$ and blue value = 80,000 (approx.).

The melting point of the pale yellow crystals was determined by evacuating at low temperatures to remove the last traces of solvent and then *very* gradually warming the cooled bath surrounding the melting point tube. To retard this rise in temperature the bath liquid was placed in a Dewar flask (transparent). The melting point ranged from 5.5° C. to 6° C., a rather satisfactory range since the resulting yellow liquid, or melt, is very viscous even at room temperatures. It is obvious that great accuracy in the determination of the melting point is difficult because of the high viscosity of the liquid.

After standing twenty-four hours with von Hubl's solution, the iodine number was 360, which corresponds to four double bonds; longer standing produced a slightly erratic increase in the iodine number. It is probable that addition to the double bond in the ionone ring is difficult.

Purely preliminary quantitative determinations of carbon and hydrogen in this product seem to indicate a carbon content of approximately 83.5 per cent. and a hydrogen content of approximately 10.5 per cent. (with remaining fraction ascribed to oxygen); these values will be corrected at an early date. Molecular weight determinations as well as biological tests are in progress and will be reported later.

HARRY N. HOLMES
RUTH E. CORBET

OBERLIN COLLEGE
DECEMBER 19, 1936

[1] Ishinagi liver oil furnished through the courtesy of the Mead Johnson Company.

STREAM DOUBLE REFRACTION OF PREPARATIONS OF CRYSTALLINE TOBACCO-MOSAIC PROTEIN

PREVIOUS experiments[1] have indicated that under certain conditions the concentration of tobacco mosaic virus in plant juice shows a high positive correlation with the intensity of stream double refraction produced by the juice. These results and others have indicated that the virus in plant juice may be composed of submicroscopic rod-shaped particles capable of causing stream double refraction.

Stanley[2] has obtained crystal preparations from infective juice which contain a high concentration of virus and has obtained considerable evidence that these crystals are the virus in a crystalline state. We have prepared crystals by means of Stanley's method and by a combination of certain steps in Vinson and Petre's[3] and Stanley's methods. Space does not permit giving the details of this combination method. For brevity the crystals prepared by Stanley's method will be called "Stanley crystals" and those prepared by the combination method "C crystals." It was found that the use of a Zeiss cardioid dark field condenser in

[1] W. N. Takahashi and T. E. Rawlins, SCIENCE, 81: 299–300, 1935.

[2] W. M. Stanley, *Phytopath.*, 26: 305–320, 1936.

[3] C. G. Vinson and A. W. Petre, *Bot. Gaz.*, 87: 14–38, 1929.

the microscope enables one to observe the structure of the crystals much better than is possible when a bright field condenser is used. The Stanley crystals were needle-shaped, appeared to have a granular structure and were admixed with a relatively small number of spheroidal particles. The "C" crystals were also needle-shaped, but were smooth in outline; this preparation appeared to contain fewer spheroidal particles than the Stanley preparation. The spheroidal particles were detected only when the dark field condenser was used. The optical activity of each preparation was determined; that of the Stanley preparation was found to be $[\alpha]_D^{22^\circ}$ per mg nitrogen $= -38$, and that of the "C" preparation was -40. Stanley[2] reported the optical activity of his two samples of crystals to be -42 and -44. The fact that these 4 results are reasonably close, that the crystals are small needles similar to those of Stanley and that the virus concentration in these preparations is high indicates that these crystals are composed of the same material as those obtained by Stanley.

It was found that suspensions of the visible crystals in ammonium sulfate solution produced stream double refraction and that colloidal solutions of the crystals in buffers also showed this phenomenon. As much as 96 parts of buffer solution could be added to 1 part of the suspension of crystals before the solution reached the critical dilution. (The critical dilution is that dilution at which stream double refraction becomes undetectable.) By means of the first order red plate of the polarizing microscope it was found that the vibration direction of the slow ray of polarized light was always parallel to the direction of flow. This relation has also been observed in unpurified virus preparations. If these crystal preparations are pure virus, as many assume, it must be concluded that the virus can exhibit stream double refraction and, when in solution, is probably composed of submicroscopic rod-shaped particles.

Determinations were made of the critical dilution and active virus concentration in solutions of both of the crystalline preparations and in unpurified virus. The influence of pH on critical dilution and on active virus concentration was also determined. The number of local lesions produced on *Nicotiana glutinosa* L. was used as an indicator of active virus concentration. It was found that a given sample of virus produced approximately 14 per cent. more local lesions when at pH 7 than at pH 5.6. Conversely, a given sample of virus at pH 7 had a critical dilution approximately 36 per cent. lower than at pH 5.6. In other words, the number of local lesions produced was higher and the stream double refraction lower at pH 7 than at 5.6. These relations were found to hold for unpurified virus as well as the crystal solutions. As a hypothesis to explain this relation we would suggest that the virus is peptized at the higher pH and that more particles are therefore available to cause local lesions. To account for the lowered stream double refraction at pH 7 we would suggest that the refractive index of colloidal particles is probably lower at pH 7 than at 5.6; this should decrease the stream double refraction.

When stream double refraction is being used to determine the concentration of active virus the unknown and control should, as may be inferred from the above results, always have the same pH.

When solutions of crystals were diluted to the critical dilution the solution of Stanley crystals produced about twice as many local lesions as the solution of "C" crystals. When a critical dilution of unpurified control virus was compared with those of crystal solutions the solution of Stanley crystals produced an average of 24 per cent. less and the solution of "C" crystals 57 per cent. less lesions than did the unpurified virus. If the crystal preparations are pure, these results indicate that a significant portion of the virus in the crystals has become inactive during the purification process and that this inactivation is greatest in the "C" preparations.

WILLIAM N. TAKAHASHI
T. E. RAWLINS
UNIVERSITY OF CALIFORNIA

GENES AFFECTING RESPONSE OF NICOTIANA TABACUM HYBRIDS TO TOBACCO-MOSAIC VIRUS

IN *Nicotiana tabacum* L. and *N. paniculata* L. tobacco-mosaic virus (tobacco virus 1, *distorting* strain) causes a mottling-type disease, whereas in *N. rustica* L. and *N. glutinosa* L. the same virus causes necrosis. In a recent paper,[1] it was reported that a dominant gene, controlling necrotic type of response, was transferred from *N. rustica* to a self-fertile derivative of *N. paniculata* by hybridization of the two species, followed by repeated backcrosses to the recessive-type parent, and eventual self-pollinations. In the derived strain of *N. paniculata,* infection induced a necrotic-type, instead of a mottling-type, disease. This gene has now been carried from the necrotic-type strain of *N. paniculata* to plants of [(*N. paniculata* × *N. tabacum*) × *N. tabacum*] × *N. tabacum.* There were considerable deviations from 1 : 1 ratios of necrotic-type to mottling-type plants in the backcross generations.

A similar gene for necrotic-type response has been transferred from *N. glutinosa* to three generations of hybrids with *N. tabacum.* All plants gave a necrotic-type response in the first generation hybrid *N. taba-*

[1] F. O. Holmes, *Phytopath.*, 26: 1007, 1936.

cum × *N. glutinosa;* similar F_1 plants have been produced and tested several times in the past.[2] All plants of this first hybrid generation have proved sterile. Because of this sterility, transfer of the gene to further generations was accomplished only by the use of *N. digluta* (fertile amphidiploid *glutinosa-tabacum*). There was uniform necrotic-type response in all plants of the generation *N. digluta* × *N. tabacum.* Segregation occurred in the subsequent backcross generation (*N. digluta* × *N. tabacum*) × *N. tabacum,* mottling-type plants being present in excess of expectation.

It is not yet known whether these necrotic-type genes characteristic of *N. rustica* and *N. glutinosa* can be incorporated in strains of *N. tabacum.* The work here reported is being continued with a view to securing an answer to this problem, because it is believed that tobacco mosaic would be unable to maintain itself in tobacco varieties bearing these genes, and that this disease, now prevalent in such other crops as tomatoes and peppers, might disappear if the virus reservoir in tobacco were eliminated or considerably reduced.

F. O. HOLMES

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH
PRINCETON, N. J.

A VASOPRESSOR LOCAL ANESTHETIC[1]

ONE of the disadvantages of procaine (novocaine) and its known relatives is that they tend to dilate the peripheral vessels. They cause a pronounced fall in blood pressure[2,3,4] as does cocaine,[5] in the ordinary concentrations.

We report the discovery of a new local anesthetic which is vasopressor.

The action of cocaine is dependent upon the presence of a nitrogenous nucleus, an esterified carboxyl and a benzoyl group. The non-alkaloidal local anesthetics owe their action to the benzene nucleus, a carboxyl esterification, and the presence of an amino group para to the above carboxyl.

On these assumptions the search for ideal local anesthetics has proceeded in two directions: (1) derivatives containing a cyclic nitrogen, and (2) derivatives of the amino and oxyamino benzoic alkyl ester type.

Koller[6] first discovered the anesthetizing effect of cocaine on the tongue and in the eye in 1884. Einhorn[7] produced local anesthesia in 1899 by esters of aminobenzoic acid. He introduced procaine, better known as novocaine (p-aminobenzoylbetadiethylaminoethanol), in 1905.

In 1903, Braun reported that the anesthetic effect of cocaine is greatly enhanced by the addition of epinephrine,[8] which is similarly efficient with procaine. Procaine dilates the blood vessels and hastens the exit of the anesthetic from the site of action. With epinephrine the duration of anesthesia is prolonged for over an hour; thus the concentration of the anesthetic can be considerably lowered; the danger of poisoning is also decreased. These results are due to vasoconstriction produced by epinephrine, which practically arrests absorption into the circulation. On the other hand, the nervousness induced by epinephrine in hypersensitive individuals is objectionable; further, it may make them susceptible to cocaine collapse. The epinephrine combination is useless on the intact cornea and for intravenous and subdural injections.[9] The greatest use of the epinephrine combination is in operations involving bleeding; although cocaine is somewhat hemostatic, procaine and the other known synthetic derivatives tend to increase bleeding.

Thus epinephrine is used with all the local anesthetics of *both* types to prevent general absorption and combat the depressor effect of the anesthetic.

In 1931, under the supervision of Professor Nelson and Dr. Powell, of the Department of Chemistry of Columbia University, we began the preparation of a compound that would combine the actions of epinephrine and of procaine. After discarding many such drugs because of undesirable effects we have finally synthesized alpha (3, 4-dihydroxyphenyl) beta (para-aminobenzoylbetadiethylaminoethanol) alphaethanonehydrochloride, designated for brevity as *epicaine,* which is both a local anesthetic and vasopressor.

We have shown that sympatheticomimicity is greatest in a compound in which the phenyl-hydroxyls are in the 3, 4-position, there is a two-carbon side-chain, a beta-carbon hydroxylated, and an alpha-carbon hydrogen substituted by some indifferent molecule, preferably an amine (but not necessarily so), and, where all these are present, a levorotatory isomer.[10] Our new compound contains these as well as the requisites enumerated above for local anesthesia.

By Rider's method[11] using the frog's sciatic plexus

[2] H. A. Allard, *U. S. Dept. Agr. Bull.,* 40, 1914; J. Johnson, *Am. Jour. Bot.,* 23: 40, 1936; F. O. Holmes, *Phytopath.,* 24: 984, 1934.

[1] From the DeLamar Institute of Public Health, College of Physicians and Surgeons, Columbia University.

[2] Roth, *Hyg. Lab. Bull.,* 109, 1917.

[3] Roth, *Jour. Pharm. and Exp. Ther.,* 9: 352, 1917.

[4] Osborne (to be published).

[5] v. Anrep, *Arch. ges. Physiol.,* 21: 38, 1880.

[6] Koller, *Sitb. Wien. Akad., Math. N. W. Kl.,* Nov., 1884.

[7] Einhorn, "Annalen d. Chemie," 1899.

[8] Braun, "Local Anesthesia," 1914.

[9] Sollman, *Jour. Pharm. and Exp. Ther.,* 11: 1, 9, 69, 159, 1918.

[10] Mulinos and Osborne, *Proc. Soc. Exp. Biol. and Med.,* 32: 1344, 1935.

[11] Rider, *Jour. Pharm. and Exp. Ther.,* 39: 329, 1930.

we demonstrated the ability of *epicaine* to produce definite sensory anesthesia within one minute in a ½ per cent. strength. We further studied the cat's blood pressure, the uteri of the guinea pig and cat, the gut of the cat, rabbit and monkey, the excised frog's eye and the pupil in the intact cat. In all these the effect was sympatheticomimetic in type.

A more complete study of the pharmacological actions of this drug is now in progress and will be reported in the near future.

RAYMOND L. OSBORNE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

DIFFERENTIAL STAINING FOR LIVING AND DEAD CELLS

IN a series of investigations on the mechanism of cellular death with the epidermal cells of *Allium cepa*, I used as a method of differential diagnosis of living and dead cells either the classical Ruzicka's[1] stain (methylen blue and neutral red) or some staining mixtures proposed by later investigators, as, for example, Becquerel's[2] stain (methylen blue, neutral red and Bismarck brown). With these stains the difference in color between the living and the dead cells is often sufficient for a reliable diagnosis of death, but it is never very "contrasty," and most of the time one wishes for a more definite criterion. In search of sharper contrast I tried the simple method of first using a stain which would penetrate both the living and the dead cells and afterwards of applying a reagent which would enter the dead cells only and modify in them alone the color of the stain. The results were, as far as contrasts are concerned, beyond all expectation.

The procedure is as follows: A piece of the lower epidermis of the scale of the onion bulb is peeled off and placed, cutin side down, on a slide. A drop of a .5 per cent., slightly alkaline, aqueous solution of neutral red is deposited on the piece of epidermis and left there for 2 minutes; then it is blotted off and replaced by a drop of a .4 per cent. potassium hydroxide solution, which is immediately removed (also with a blotter); then the preparation is washed with tap water. The living cells take with that treatment a bright cerise red color, while the dead cells are of an intense orange yellow. The contrasts are violent. There are intermediate tints which correspond to the dying cells.

A cell treated with a .4 per cent. solution of KOH may stay alive for hours (if the piece of epidermis is to be observed without cover-slip, put its cutin side up, to avoid evaporation). Lower concentrations of KOH can be used, but they should be applied for a longer time; higher concentrations up to 1 per cent. were also used successfully; above 1 per cent. they become too injurious, but they are not instantly lethal up to 2.5 per cent.

[1] V. Ruzicka, *Pflügers Arch.*, 107: 473, 1905.

[2] P. Becquerel, *Comptes Rendus Ac. Sc.* 176: 601, 1923.

With solutions of neutral red weaker than .5 per cent., the staining process requires a longer time.

The correspondence between the vitality of the cells and their color has been ascertained by testing cells of a given tint for their ability to plasmolyze, their ultra-violet absorption (Luyet and Gehenio's[3] method), and their permeability to various vital and non-vital stains.

Paradoxical as it may seem, the living cells become redder when the action of KOH is prolonged. This is probably due to the production of an "acid of injury" within the cell.

The method employed has been found successful particularly with cells which possess a well-developed vacuolar system. This is consistent with the fact that neutral red, as a vital stain, acts specifically on the vacuome (*cf.* Guillermond[4]).

BASILE J. LUYET

DEPARTMENT OF BIOLOGY
ST. LOUIS UNIVERSITY

THE PREPARATION OF FINE FILAMENTS

THE special article entitled "Simplified Preparation of Microscope Cross Hairs"[1] by A. Wilson Footer indicates a most important method for the easy production of fine filaments of desired size. The dissolving of the silver coating on fine (Wollaston) wires of 0.0001 inch in diameter or 0.00005 inch in diameter and the securing of the core wire intact is an operation with which only the skilled technician is likely to have success.

However, using the commercial adhesive (I understood this to be Duco Household Cement, 10-cent tube), it is possible after a few minutes' experimentation to draw out with the aid of a probe short filament sections, having diameters as small as 0.00005 inch, which can be easily mounted on grids.

Measurement of exact diameter of a section of the filament may be made with a filar micrometer.

JOSEPH B. FICKLEN

HARTFORD, CONN.

[3] B. J. Luyet and P. M. Gehenio, *Biodynamica*, No. 11, 1936.

[4] A. Guillermond, "Les Constituants Morphologiques du Cytoplasme: Le Vacuome," p. 10. Paris, 1935.

[1] SCIENCE, 84: 490, 1936.

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SCIENCE AND THE AMERICAN PRESS[1]

By DAVID DIETZ

SCIENCE EDITOR OF THE SCRIPPS-HOWARD NEWSPAPERS

THERE was a time when a speaker at a session of the American Association for the Advancement of Science spoke only to those within the sound of his voice. To-day, he may speak to the entire nation.

Even as he stands upon the platform, his words may be going over the telegraph wires to newspapers in every part of the country. In the case of the address of the president or one of the vice-presidents or in the case of an address containing some discovery of outstanding importance, the telegraphed account may run to several thousand words.

Each day of the meeting, the larger metropolitan newspapers of the nation devote from one to five columns to reports of the papers presented. The total amount of space devoted by the newspapers of the nation to the meeting is in excess of a thousand columns per day.

This is a fact of major significance in American life. It represents a change of the first order in the character and meaning of these annual meetings. It possesses profound importance for the progress of science, the conduct of journalism and the future of the nation.

The fine and friendly relations which now exist between the scientists and the press is symbolized by the fact that you have invited me to be the speaker of this general session to-day. As the former president of the National Association of Science Writers, I think that I may say that the growth of this accord has been the source of great pride and satisfaction to all its members.

There was a day when the newspapers had no interest in the reporting of science. Those were the days

[1] Address given at the general session of the American Association for the Advancement of Science, Atlantic City, December 29, 1936.

when a scientific convention was regarded as an assignment for the staff humorist. There were two accepted and traditional methods of reporting such a convention. One was to comment upon the length and luxuriousness of the beards worn by the assembled savants, the other was to make a collection of those titles of papers which contained the longest words and the ones least familiar to the ordinary reader.

The scientists, on their part, viewed the newspapers only with hostility and disdain. They asked nothing better than to be left alone to carry on their deliberations in quietness and privacy.

A change began to manifest itself after the world war, when a new public interest in science sprang up. I think that a number of causes contributed to this. One was the war itself. The war emphasized the importance of science because it was fought with weapons forged by science, new big guns, new high explosives, poison gases, airplanes and submarines.

Following the war came the wide-spread popular interest in radio. Every one was interested in this marvelous invention which brought voices and music out of the air. They wanted to know how it worked.

A third contributing factor was the post-war interest in the Einstein theory of relativity. The confirmation of Professor Einstein's prediction that the star images would be found displaced upon photographs of a solar eclipse was spectacular and dramatic. Every one wanted to know about the Einstein theory and the more that they were told they could not understand it, the more determined they were to hear about it.

To the best of my knowledge, the first newspaperman to sense this new interest in science and to see the importance of furnishing accurate and dependable scientific information to the public in a day when the world was becoming increasingly dependent upon the discoveries of science, was that far-seeing genius of journalism, the late E. W. Scripps. Mr. Scripps, after a number of conferences with the leading scientists of the nation, organized Science Service and installed the late Dr. E. E. Slosson as its first director. About the same time, I was given my first opportunity to write scientific news by George B. Parker, then editor of *The Cleveland Press.* Subsequently, when Mr. Parker became editor-in-chief of the Scripps-Howard Newspapers, I was made science editor of that chain. There were others who entered the field about the same time—Watson Davis, now director of Science Service, who became one of Dr. Slosson's first assistants, and Alva Johnston, then of the *New York Times,* who won the Pulitzer prize in journalism for his reporting of the Boston meeting of the American Association for the Advancement of Science in 1922.

That meeting in Boston was the first one to be reported in a serious and thorough fashion with a genuine effort to interpret its importance to the public. Present at it were Dr. Slosson and Mr. Davis, representing Science Service; Mr. Johnston, representing the *New York Times,* and myself, representing the Scripps-Howard Newspapers.

While I am speaking of 1922 and the years that followed soon after, I would like to express a word of appreciation for the scientists who were among the first to help and encourage us in the work that we were trying to do. Foremost among them was Dr. D. T. MacDougal, then general secretary of the A. A. A. S. Dr. MacDougal was at all times sympathetic and helpful and we remember with gratitude the cooperation which he gave us.

Others who were very helpful in those early days included Dr. Burton Livingston, then permanent secretary of the American Association for the Advancement of Science; Dr. F. R. Moulton and Dr. W. D. Harkins, of the University of Chicago; the late Dr. Michael Pupin, of Columbia University; Dr. E. B. Wilson and Dr. Harlow Shapley, of Harvard University; Dr. J. McKeen Cattell, the editor of SCIENCE; President John C. Merriam, of the Carnegie Institution of Washington; Mr. Austin H. Clark and others. The appointment subsequently of Mr. Clark as press director of the association marked an important step forward in the relations between the press and the scientists of the nation, and all of us are indebted to Mr. Clark for his excellent service.

I wish also to say a word about the treatment accorded us in those early days of scientific reporting by the American Philosophical Society. We were always made to feel welcome at their meetings. Many courtesies were shown us by the officers and staff of the society, and I am sure that we shall always look back to those days with the most pleasant of memories. I would like also to say a word about the help accorded me in those early days by two fellow Clevelanders, both members of the National Academy of Sciences—Ambrose Swasey, the telescope builder who recently celebrated his ninetieth birthday in good health, and Dr. Dayton C. Miller, past president of the American Physical Society.

With the continued growth of public interest in science, a number of important newspaper organizations began to turn their attention to the subject of science. The Associated Press and the Hearst Newspapers engaged science editors, while such newspapers as the *New York Times,* the *New York Herald-Tribune, Washington Star, Detroit News* and others assigned men to devote their major efforts to the field of science. In time there developed a group of science

writers who attended all the major scientific meetings of the year.

In April, 1934, when the business of organizing seemed to be becoming the great American pastime, we decided that we too ought to organize, and so the National Association of Science Writers came into existence.

Charter members of the association were Howard Blakeslee, science editor of the Associated Press; Ferry B. Colton, at that time assistant science editor of the Associated Press; Watson Davis, director of Science Service; Victor Henderson, of the *Philadelphia Inquirer;* Thomas R. Henry, of the *Washington Star;* Waldemar Kaempffert, science editor of the *New York Times;* Gobind Bahari Lal, science editor of the Hearst Newspapers; William L. Laurence, science news editor of the *New York Times;* John J. O'Neill, science editor of the *New York Herald-Tribune;* Robert D. Potter, of Science Service, and myself.

My colleagues honored me with the distinction of being chosen the first president of the association. The office of president is held at the present time by Mr. Blakeslee.

At subsequent meetings, the membership was extended to include Herbert B. Nichols, physical science editor of *The Christian Science Monitor;* Jane Stafford and Marjorie Van De Water, of Science Service, and Steve McDonough, of the Associated Press.[2] Honorary membership has been conferred upon two distinguished scientists who have rendered conspicuous service in furthering the relationship of science and the press, namely, Austin H. Clark and Dr. J. McKeen Cattell.

The National Association of Science Writers has only one purpose. This is set forth clearly in its constitution as follows: "To foster the dissemination of accurate scientific knowledge by the press of the nation in cooperation with scientific organizations and individual scientists."

I do not believe that any scientist may feel that he has completed his work when he has finished a piece of research in the laboratory. It is likewise his duty to disseminate the new knowledge which he has uncovered. And to-day, publication in a journal read by a circle of his colleagues is not sufficient. The welfare of society demands that the general public be made aware of scientific progress. This can be done only through the newspapers, and hence the scientist to-day must be willing to cooperate with the newspaperman.

How such cooperation works out to the mutual interest of the scientist and the public was demonstrated at the Pittsburgh meeting of the association in December, 1934. Present as the invited guest of the association was Professor Albert Einstein of relativity fame. His presence was equally interesting to scientists, newspapermen and newspaper readers.

Now Professor Einstein might have declined to see newspapermen, or the scientists in charge of his appearance in Pittsburgh might have refused to cooperate with us. In that event there probably would have been many attempts to obtain some sort of statement nevertheless with much unpleasantness for every one concerned.

Instead, Mr. Clark, assisted by officials of the American Mathematical Society, undertook to arrange an interview. The time was set early enough in the morning to make it possible to get the interview written and on the telegraph wires in time for publication in afternoon newspapers.

A list of questions prepared by a committee of the National Association of Science Writers was submitted to Professor Einstein in advance of the interview. It was understood by mutual agreement of both members of our association and the local reporters that Professor Einstein was to be asked questions only in the realm of science. As a result, the interview was conducted with dignity and dispatch. Professor Einstein, who on previous occasions had expressed a distaste for being interviewed, said that he enjoyed the event.

What Professor Einstein said at the interview was reported accurately and with dignity and published widely throughout the nation. My own interview was sent by the United Press not only to its clients throughout the United States but cabled as well to South America and Europe. And I am sure that the accounts written by Mr. Blakeslee for the Associated Press, by Mr. Lal for the Hearst Newspapers and by other members of our association received the widest distribution.

I would like also to mention the press arrangements at the Harvard Tercentenary Celebration this past September. I am sure that every member of the National Association of Science Writers joins me in this tribute to the wisdom and efficiency of the officers of Harvard University and all those members of the faculty who cooperated during the three weeks of the celebration and in the weeks of preparation beforehand. I regret that time does not permit me to mention by name all those who were of such great assistance to the press.

As you know, Harvard University invited some seventy-five of the most famous European scholars

[2] Since the presentation of this address, the membership has been further extended to include Philip Kinsley, of the *Chicago Tribune;* Hillyer Kriegbaum, of the United Press; L. E. Levick, of the *New York Evening Journal,* and Steven M. Spencer, of the *Philadelphia Evening Bulletin.*

as well as many distinguished American scholars to take part in the tercentenary celebration. The Harvard News Office, which is under the direction of Mr. Arthur Wild, had mimeographed copies of every address upon the program available for the press.

Collecting these manuscripts in advance was in itself considerable of a task. In addition, where the original manuscripts were in French or other foreign languages, members of the Harvard faculty made translations.

Two additional services were provided by the Harvard committee which were of the utmost importance to the newspapermen reporting the tercentenary. First, the committee arranged press conferences with such of the distinguished guests as a majority of the newspapermen desired to meet. These conferences, held under pleasant circumstances, well in advance of the particular individual's appearance upon the program, made possible a clarification of complex or involved points in the manuscripts and supplied the newspapermen with direct answers to questions which were in their mind.

Next, the committee appointed members of the Harvard faculty to act as liaison officers between the press and the various symposia and programs. This enabled newspapermen to check their impressions of the importance of various sessions, the bearing of one paper upon another, and other important points, with competent and responsible authorities.

The upshot of the matter was that the newspapermen were able to report the conference with accuracy, with dignity and with completeness. I do not believe that there was a city in the United States whose newspapers did not carry columns of reports of the Harvard meetings. As a result, the opinions of the savants gathered at Harvard were carried into the thinking of the whole nation.

In this connection, I would like to quote one sentence from a letter which I received this month from Mr. Jerome D. Greene, who was chairman of the executive committee of the Harvard Tercentenary Celebration. Mr. Greene wrote: "There seems to be general agreement that the press set a new standard by the fullness and readable quality of its reports on the formidable range of subjects covered by the Conference."

Mr. Greene's opinion is a great source of satisfaction to the members of the National Association of Science Writers and to the other newspapermen who reported the Harvard Tercentenary Conference. It repays them for the many hours of hard work and conscientious effort which went into the weeks of the conference.

This brings me to a subject which, I think, it is preeminently fitting to discuss here. Each year, the Press Bureau of the American Association for the Advancement of Science requests that you send in copies of your manuscripts or abstracts of them as early as possible. Some of you may not realize how important this is. If you will think for a moment in terms of the mechanics of newspaper reporting, you will understand the situation.

Each day, there are some twenty or thirty sectional meetings in session. The important papers on any day may be read in various sections meeting in widely separated buildings. Even if all the papers in which a particular newspaperman was interested were read in one meeting, the time element would still have to be taken into consideration. A reporter can not sit through a long session, return to his typewriter and still get his account into the day's newspapers. He must have the papers in advance.

Moreover, for the sake of accuracy, it is to the scientist's own advantage to provide the Press Bureau with copies of his manuscript. The reporter is just as eager to be accurate as the scientist is to have him accurate. The members of the National Association of Science Writers are writing daily articles under their own signatures. They have every reason for desiring to maintain their own reputations for reliability and accuracy.

Perhaps you may wonder why the newspapermen desire both complete manuscripts and abstracts. The answer to that question is again one of the mechanics of the situation. No reporter has sufficient time to read all the thousand or more papers in the Press Bureau. But with the aid of the abstracts, he can get a grasp of the essentials of each paper and then turn to the completed manuscript in those cases where he wishes greater amplification or wishes to quote the scientist at some length.

A word should also be said about the preparation of abstracts. Unfortunately, there is a certain type of abstract which is of no value at all. This is the sort of abstract which does not tell what is in the paper but merely tells what the paper is about. Let me give an illustration which is wholly fictitious, but which never the less is typical of what I have in mind.

Let us imagine that our fictitious paper has been written by an astronomer. His abstract reads as follows: "This paper will recount some researches carried on during the past year with a new kind of telescope. The telescope will be described. Some new results obtained in observations of the spiral nebulae will be described and their bearing upon theories of the evolution of the universe will be discussed."

Now it will be obvious at once that this abstract tells us nothing about what is really in the paper.

We have no notion of what the telescope is like, how it was used, what was discovered with it or what conclusions were drawn from it.

The best advice that I can give you is that you play that you are a newspaperman when you write the abstract of your paper. Make it a condensed statement of your paper with all the important facts in it.

By now, you may wish to say something like this to me: You have spent a lot of time lecturing the scientists upon what they should do for the newspapers. What in return may we expect from you?

Let me say that there are many things which you have a right to expect, and I think that those of you who know the science writers best will agree that we are doing our utmost to live up to these expectations.

The scientist has every right to expect that he will be treated with fairness and respect. He has every right to expect that his paper will be reported with accuracy and with dignity, with no distortion of emphasis and with no unfair implications. He has the right to expect that the report will be such that both his own colleagues and the general public will get a fair and adequate picture of his work from it.

These are things which I know he will get at all times from members of the National Association of Science Writers. Our members are alert to their responsibilities and duties. We take the same pride in our work that the scientist does in his.

Let me turn now to the field in which the scientists of America and the newspapers of the country may cooperate, not merely for their mutual benefit but for the benefit of the entire nation. This, after all, is the most important field of all, since it justifies the existence of both the scientist and the newspaper.

The outstanding characteristics of the age in which we live are the result of the application of science to life. The span of life itself has been lengthened by the advance of medical science. The rapid and amazing developments of industry in the present century have been due to the triumphs of the scientific laboratory. First industry turned chiefly to the chemist. More recently it has turned to the physicist.[3]

In 1900 the electron was a theory. To-day, the world has put the electron to work. In the vacuum tubes of our radio sets, in the photoelectric cell, in other electronic tubes and in the x-ray tube, we are making daily use of the electron.[4]

The world is constantly changing under our very eyes. To-day, with the end of the depression, we are moving into a new world, a world of taller buildings, longer bridges, swifter trains, safer aircraft, finer homes, a world of greater beauty, deeper comfort, smoother efficiency.

Now that the depression is over, we must guard against the habit which we may have formed during the years just past, namely, the habit of thinking in terms of the depression. In planning for the future we must think in terms of America, not in terms of the depression.[5]

Nature has intended America for a great future. It has favored this nation above all others with natural resources. Equalling our mineral resources are our vast agricultural lands, timber, fisheries and water power.

But how fully we attain that future depends upon how adequately we plan our national program of scientific research.

The situation was extremely well expressed by the Science Advisory Board, of which Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, was chairman, in its first report to President Roosevelt.

"In the evolution of our national life," the board reported, "we have reached the place where science, and the research which has discovered and released its powers, can not be regarded as matters of accidental growth and application, but must be consciously related to our social life and well-being."[6]

Dr. Henry A. Barton, director of the American Institute of Physics, has calculated that, prior to the depression, America spent $100,000,000 annually for scientific research.[7]

Because of drastic curtailments in expenditures for research during the depression, the total spent in the nation for this purpose has fallen off 50 per cent., Dr. Barton estimates. As he observes, those short-sighted persons who thought the world would be better off if scientific research was stopped have gotten 50 per cent. of their wish.

The first great necessity is to obtain adequate support for scientific research. This means, first of all, adequate government support.

The backbone of our national research program must be the research carried on by the government. There are many problems which affect the nation at large and which are too expensive for private enterprises to undertake.

A number of European governments have seen clearly the necessity of embarking upon large-scale programs of scientific research with the backing of

[3] A. W. Hull, "Putting Physics to Work," *Review of Scientific Instruments*, 6: 377, 1935.

[4] Karl T. Compton, "The Electron: Its Intellectual and Social Significance," SCIENCE, 85: 27–37, 1937.

[5] David Dietz, "Science, Uncle Sam, and the Future," *Review of Scientific Instruments*, 7: 1, 1936.

[6] Report of the Science Advisory Board, Washington, D. C. September 20, 1934. Page 11.

[7] H. A. Barton, "Scientific Research in Need of Funds," *Literary Digest*, 119: 18, June 29, 1935.

the government. England has a program which is superior to our own.

The dictatorships of Europe have seen the importance of scientific research and are doing everything that they can to further it. Both Italy and Germany have extensive research programs. The outstanding example in this respect is Russia.

This October, the cables from Russia told of a new five-year plan. Stalin had ordered the Soviet Academy of Sciences to embark upon a five-year plan of scientific research for the development of Russia's natural resources.

In a democracy, those things which a dictator may order upon a moment's notice must be achieved more slowly. An intensive scientific program backed by government support is possible only if the public sees the need for it and asks for it.

In conclusion, I want to say a word about the important work which scientists and journalists together can do to disseminate and make clear the spirit of science. Mistaken individuals make much of what they are pleased to call the impersonality of science. They point out that the same airplane which carries a health-restoring serum to a family isolated in the frozen north can be used to drop bombs upon the women and children of Madrid. This is true, but it is not the way the scientist would have it. This is not in accord with the spirit of the scientist who toils all his life in a medical laboratory and gives his discoveries freely to the whole world.

Upon other occasions I have discussed the spirit of science.[8] In bringing these remarks to a close, I wish to do so again. Science brings a spirit, its own guiding spirit in which there is hope for mankind.

To the scientist, the practical applications have always been secondary. He has sought primarily to understand nature and the universe. This does not mean that the scientist is contemptuous of the practical uses of science. The opposite is true. But it does mean that the true scientist is motivated by a higher aim than that of making life easier.

Secondly, the spirit of science is the spirit of courage. The scientist is not bound by ancient tradition. Copernicus dared to cast aside the Ptolemaic theory, though it had dominated man's thought for centuries. Vesalius challenged the authority of Galen's anatomy, even though it had ruled since the time of the Romans.

Third, science is the spirit of tolerance. The scientist knows that there is no monopoly upon truth. He sees the advance of science as a great cooperative venture of all nations and peoples down through the years. The rôle of every science is an international one.

And finally, the scientist is humane. He is concerned for the future of mankind. The picture of the scientist as a man who shuts himself away in his laboratory like a hermit in a cave is an unfair picture.

Let Einstein, whose theories represent man's greatest flight to-day into the world of the abstract, speak for the scientist's interest in the concrete facts of life. Addressing the students of the California Institute of Technology upon one occasion, he said:

> It is not enough that you should understand about applied science, in order that your work may increase man's blessings. Concern for the man himself and his fate must always form the chief interest of all technical endeavors. Never forget this in the midst of your diagrams and equations.

To-day, as we look about us at a world over which hangs the terrifying possibility of another general war, we too must make our chief concern "man himself and his fate."

We must make it plain that science is no blind and unbridled force, careless of man and his future. The scientist is thinking of the welfare of mankind.

The scientist is conscious of the smallness of his knowledge. But he is also conscious of the greatness of the power which so little knowledge has given mankind. And so he faces the future with courage.

The ancient Psalmist, standing beneath the stars, exclaimed:

> When I consider Thy heavens, the work of Thy fingers, the moon and the stars, which Thou hast ordained; What is man, that Thou art mindful of him? And the son of man, that Thou visitest him?

But the ancient psalmist understood the greatness of man as well as the greatness of the universe, for he added:

> Yet Thou hast made him little lower than the angels, and hast crowned him with glory and honor. Thou hast made him to have dominion over the works of Thy hands; Thou hast put all things under his feet.

Science looks forward with confidence and courage to the day when man shall realize the best that is in him. In the task of realizing that day, scientists and journalists must work side by side.

[8] David Dietz, "The Story of Science," fourth ed., Dodd, Mead and Company, 1936. Pages 350–353.

SCIENTIFIC EVENTS

THE LALOR FOUNDATION

THE Lalor Foundation is organized for the advancement of scientific research and encouragement of the arts. Its activities are maintained through income from a permanent endowment fund contributed by members of the Lalor family.

The trustees are of the belief that the energy to-day directed toward research in pure science is dispropor-

tionately small compared with the effort and money expended in industrial research and applied science. Further support for purely scientific research is imperative if the boundaries of our knowledge are to be broadly extended and if overall well-balanced progress is to be maintained. The trustees have felt that a series of awards could be designed to contribute to this need. Accordingly, current income received by the foundation will be expended for awards to mature scholars of demonstrated ability to afford opportunity to them to carry on advanced research and study under the freest possible conditions.

The foundation will maintain five awards per year of $2,500 each to be paid over a twelve months' period. Appointment is open to both men and women residents of the United States and no age limit is prescribed, but the usual range of ages will be between 25 years and 40 years. High intellectual and personal qualifications as well as creative ability and capacity for productive scholarship are essential elements in the appraisal of candidates.

The fields of work in which awards will be granted are determined by the board of trustees. Prospectively for the next several years awards will be for work in various fields of chemistry and intimately related sciences. In general, the awards may be used for work anywhere. However, in recognition and memory of the late Dr. Arthur Amos Noyes, founder of the Research Laboratory of Physical Chemistry at the Massachusetts Institute of Technology, one of the awards for each of the next four years will be specifically assigned to work at that institution.

Recipients of awards are to present complete reports at the conclusion of their terms of appointment as well as informal interim reports on request. The Lalor Foundation, at its option, may contribute to the publication of important research of high merit accomplished by holders of its awards. The qualifications and attainments of the candidates as well as their proposed program of work will be passed upon by the advisory board and recommendations made to the trustees. Final selection and announcement of awards for 1937–38 will be made in February, 1937.

Officers of the foundation are:

President	Charles L. Reese
Vice-president	Anna Lalor Burdick
Treasurer	Elwyn Evans
Secretary	C. Lalor Burdick
Assistant Secretary	Doris M. Jarmon

Members of the advisory board are:

Dr. Roger Adams, head of the department of chemistry, University of Illinois.

Dr. Katharine Blunt, president, Connecticut College for Women.

Dr. Harrison E. Howe, editor, *Industrial and Engineering Chemistry*.

Dr. Henry G. Knight, chief, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

Dr. Charles A. Kraus, head of the department of chemistry, Brown University.

Dr. Arthur B. Lamb, professor of chemistry, Harvard University.

GIFT BY THE JULIUS ROSENWALD FUND TO THE COMMITTEE ON RESEARCH IN MEDICAL ECONOMICS

DR. EDWIN R. EMBREE, president of the Julius Rosenwald Fund, announces that the fund has made a grant of $165,000 over a five-year period to the Committee on Research in Medical Economics. This committee has recently been incorporated in New York, with Michael M. Davis as chairman, the other members being Robert E. Chaddock, professor of statistics, Columbia University; Henry S. Dennison, president, Dennison Manufacturing Company, Framingham, Mass.; Walton H. Hamilton, professor of law, Yale University, and director of the Bureau of Research, Social Security Board, Washington; Alvin S. Johnson, director of the New School for Social Research, New York; Paul U. Kellogg, editor of *The Survey Graphic*, New York; Harry A. Millis, professor of economics of the University of Chicago; Fred M. Stein, retired banker, New York.

The committee will have an advisory board, to be enlarged as required, the following physicians now being members: Drs. Samuel Bradbury, Philadelphia; Alfred E. Cohn, New York; Alice Hamilton, Washington; Ludwig Hektoen, Chicago, and Franklin C. McLean, Chicago.

This committee will conduct and assist studies in the economic and social aspects of medical care; will train personnel for this field, and, in cooperation with the medical profession and other agencies, will furnish information and consultation services in behalf of rendering medical care more widely available to the people at costs within their means. The committee will have headquarters in New York City.

Since 1928, Mr. Embree stated, "the Julius Rosenwald Fund has been actively at work with the aim of reducing the costs of medical services and of making them more accessible to people of small incomes. Now the organized medical profession, hospitals and many industrial and governmental agencies are engaged in practical experiments in different parts of the country, organizing medical care to reduce costs or developing methods of getting these costs into the family budget.

"Hence there is now less need for the promotion of action than for the guidance of action through scien-

tific and dispassionate studies. The fund therefore welcomes the opportunity to make a grant of this kind to a committee of social scientists and business men, with a distinguished medical advisory board. With this grant, together with the grant of $100,000 recently made to the American Hospital Association to promote voluntary hospital insurance, the trustees have terminated their department of medical services, believing that these two agencies will now carry forward vigorously the fund's long-standing and successful work in this field."

Michael M. Davis, who is chairman and the active director of the new committee, has been, since 1928, the director of the department of medical services. He has been associated for many years with work in medical economics and with hospitals and clinics in New York, Boston and Chicago, is the author of a number of books and many articles, chairman of the council of the American Hospital Association and active in numerous national public health and welfare agencies.

DU PONT FELLOWSHIPS FOR RESEARCH IN ORGANIC CHEMISTRY

THE E. I. DU PONT DE NEMOURS AND COMPANY has decided to increase the number of fellowships it awards annually to six post-doctorate fellowships and eighteen postgraduate fellowships for the academic year 1937–38. This action has been taken because of the success of the plan in encouraging and developing organic chemical research. These fellowships, which will be held at eighteen leading universities and colleges, are maintained to encourage more promising students in research work in the field of chemistry. Last year, the company awarded four post-doctorate fellowships and twelve postgraduate fellowships.

Since these awards were first offered in the academic year 1918–19, there have been granted 350 fellowships and 34 scholarships in 33 universities, and, in addition, a national fellowship was awarded at the Johns Hopkins University for a period of four years.

The purpose of the plan is primarily to promote the advancement of science and the scientific training of young men and to cooperate with the educational institutions in their efforts to carry on advanced research work. The du Pont fellowships differ from the usual industrial fellowships in that they are not restricted to research on subjects directly connected with the du Pont products. Experience has proved that the broad purpose of the plan is best served by permitting the colleges to select the beneficiary of the fellowships and the research subject as well.

An appropriation of $26,500 has been made for the year 1937–38 to be allocated as follows: $13,000 for six post-doctorate fellowships at $2,000 each, with $1,000 to cover the cost of equipment needed in the work of this group, and $13,500 for eighteen postgraduate fellowships at $750 each. The eighteen institutions selected are the University of Chicago, Columbia University, Cornell University, Harvard University, University of Illinois, the Johns Hopkins University, the Massachusetts Institute of Technology, the University of Michigan, the University of Minnesota, the University of North Carolina, the Ohio State University, Pennsylvania State College, the University of Pennsylvania, Princeton University, Stanford University, the University of Virginia, the University of Wisconsin and Yale University.

The continuation and expansion of this combination (post-doctorate and postgraduate plan) will tend to further assist the universities through the post-doctorate plan in raising the quality of organic research by enabling the promising professor selected to engage in more difficult problems through employment of trained assistants. Through the postgraduate plan it will assist promising young men to obtain further education along the lines required by the chemical industry.

The du Pont fellowship plan was inaugurated in 1918. In that year, seventeen fellowships with an average stipend of $750 were made available to sixteen universities for research in chemistry. The selection of the fellows and the thesis subjects was left entirely to the discretion of the college authorities.

MEMORIAL VOLUME TO SAMUEL C. HOOKER

A COLLECTION of papers by the late Dr. Samuel C. Hooker entitled "The Constitution and Properties of Lapachol, Lomatiol and Other Hydroxynaphthoquinone Derivatives" has been published recently as a memorial volume for private distribution to interested individuals and to libraries. The papers describe a series of chemical investigations of lapachol, a yellow substance found in the grain of certain South American woods, of lomatiol, a structurally similar pigment occurring in the seeds of certain varieties of *Lomatia*, and of related substances obtained by synthesis.

Hooker was born in England in 1864, and at the age of twenty-one he obtained his Ph.D. degree at Munich in the short period of one year. Shortly thereafter he entered the employ of the American Sugar Refining Company in Philadelphia. The lapachol work was undertaken in 1889 and actively pursued in such time as was not devoted to his technological duties, and a series of eleven principal papers was published in *The American Chemical Journal* and in the *Journal of the Chemical Society* in the years 1889 to 1896. Increasing responsibilities in the industry made it necessary to discontinue the researches in organic chemistry

for nearly twenty years, but at the age of fifty-one Hooker retired and devoted a considerable part of his time in the last twenty years of his life to a continuation of the early work in the lapachol field. Publication of the results which accumulated during this period was withheld from a desire to bring the various interrelated problems to the point of well-rounded completion. This point had been reached at the time of Hooker's death on October 12, 1935, and the investigations were reported in a series of eleven posthumous papers published in the July issue of the *Journal of the American Chemical Society* for 1936. These papers, which form a natural and logical continuation of those published forty years earlier, are reprinted with the earlier papers in the memorial brochure. The history of the investigations provides an unusual example of disinterested and sustained devotion to the quest of truth.

Included in the introductory material of the volume is an obituary sketch by Dr. C. A. Browne, supervisor of chemical research of the Bureau of Chemistry and Soils. This sketch, which is reprinted with some additional notes and details from the *Journal of the Chemical Society* (1936), includes an account of Hooker's activities in other fields, for he not only was distinguished as an organic chemist but made significant contributions as a sugar technologist, a collector of books and of works of art and as an amateur magician.

The publication of the memorial volume was authorized and financed by members of Dr. Hooker's family. The volume is edited by Professor Louis F. Fieser, Converse Memorial Laboratory, Harvard University, from whom copies desired by individuals or for libraries may be obtained on application.

PRESENTATION OF THE PHILIP A. CONNÉ GOLD MEDAL TO DR. VAN SLYKE

DR. DONALD DEXTER VAN SLYKE, chief chemist of the hospital of the Rockefeller Institute for Medical Research, received the Philip A. Conné Gold Medal for 1936 of the Chemists' Club of New York, for "systematic and painstaking work of immense importance to clinical medicine," at a dinner given at the club on January 22.

Dr. Van Slyke won the medal "in recognition of his methods of blood analysis and gasometric micro analysis, and of his work on respiratory and renal reactions, diabetes and nephritis." The presentation was made by Professor Marston Taylor Bogert, of Columbia University. Dr. A. Baird Hastings, of the Harvard University Medical School, and Dr. Glenn E. Cullen, of the Children's Hospital Research Foundation and the Department of Pediatrics of the University of Cincinnati, both of whom have collaborated with Dr. Van Slyke in researches, spoke on the scientific contributions of the medalist and personal aspects of his career. Dr. Frederick G. Zinsser, of Hastings-on-Hudson, president of the club, presided.

Dr. Van Slyke said that he accepted the award as "recognition of the chemists and young physicians, laboratory comrades of a score of years, who have really done the work mentioned by the medal committee." His medal address was entitled, "Mechanism of Neutrality Maintenance in the Body."

Dr. Van Slyke was born at Pike, N. Y., in 1883. His father, Lucius Lincoln Van Slyke, was chief chemist of the New York State Agricultural Experiment Station at Geneva, N. Y., from 1890 to 1931. After studying for a year at Hobart College, Dr. Van Slyke entered the University of Michigan, where, after working with Professor Moses Gomberg on derivatives of triphenyl methyl, he received the degree of doctor of philosophy in 1907. Since then he has been associated continuously with the Rockefeller Institute for Medical Research.

On leave of absence he was a graduate student at the University of Berlin in 1911. He was visiting professor at the University of California in 1917 and at the Peiping (China) Union Medical School in 1922. In the World War, at the request of the Surgeon General of the Army, he organized at the Rockefeller Institute a training class for chemists in the sanitary corps, and on the completion of this work in 1918 he was appointed a major in the sanitary corps, but the armistice prevented his receiving his commission.

From 1907 to 1914 he worked in the laboratory of P. A. Levene, with whom he was associated in studies of proteins and amino acids. During this period he developed the nitrous acid method for gasometric measurement of nitrogen in primary aliphatic amino groups, and with Gustav Meyer used the method to trace the path of protein digestion products through the animal body. From 1914 to the present he has been chief chemist at the hospital of the Rockefeller Institute. His studies there have been directed partly to problems of theoretical and analytical chemistry and partly to problems in clinical and related physiological fields.

The Conné Medal was founded by Mrs. Philip A. Conné, New York City, in memory of her husband. It is given annually "irrespective of color, creed, domicile, nationality or sex, to an individual responsible for a discovery in chemistry which has proved of value in the treatment of human disease." Previous recipients have been John J. Abel, H. D. Dakin, Lafayette B. Mendel and Edward Doisy.

Members of the medal jury, besides Professor Bogert, were Professor D. D. Jackson, of Columbia University, Dr. Walter W. Palmer, of the Presbyterian Hospital, New York; Dean William T. Read, of Rutgers University, and Dr. Leonard G. Rowntree, of the Philadelphia Institute for Medical Research.

SCIENTIFIC NOTES AND NEWS

THE Sylvanus Albert Reed Medal of the Institute of Aeronautical Sciences was presented to Professor Edward S. Taylor, of the Massachusetts Institute of Technology, at the annual dinner of the Aeronautical Institute on January 28 at the Columbia University Faculty Club. Professor Taylor received the award in recognition of his invention of the dynamic vibration absorber.

DR. JAMES B. CONANT, president of Harvard University, has been elected a member of the Athenaeum Club, London, under the provision which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts or for public service.

THE Order of B'rith Abraham has established a new lodge in honor of Dr. Einstein to be known as the Albert Einstein Lodge.

AMONG alumni awards of merit to be conferred on Founders Day on January 23 by the University of Pennsylvania are the following: Dr. George E. de Schweinitz, emeritus professor of ophthalmology and trustee of the university; Dr. Robert Tait McKenzie, research professor of physical education, and Dr. Witmer Stone, vice-president of the Philadelphia Academy of Natural Sciences, director emeritus of the museum and director of North American Birds and Historical Research.

THE *Journal* of the American Medical Association reports that the January, 1937, issue of the *Archives of Dermatology and Syphilology* is a special number dedicated to Dr. William Allen Pusey. The volume was authorized by the Board of Trustees of the American Medical Association in recognition of the founding of the publication by Dr. William Allen Pusey and of his service to it since that time. All the contributors have been associated with Dr. Pusey in various activities. Dr. Pusey retires as editor of the *Archives of Dermatology and Syphilology* with the current issue. The new editor, Dr. Howard Fox, concludes the special issue with an editorial rendering tribute to the manner in which the *Archives* has been conducted by Dr. Pusey.

HONORARY membership in the Explorers Club of New York was conferred on January 18 at a luncheon at the Soviet Embassy in Washington, D. C., on Dr. Otto Yulievich Schmidt, professor in the University of Moscow and director of the Soviet Arctic Institute, in recognition of his "leadership and outstanding achievements in Polar exploration."

THE College of Physicians of Philadelphia has elected the following officers for the year 1937: *President,* Dr. George P. Müller; *Vice-president,* Dr. Edward B. Krumbhaar; *Secretary,* Dr. J. Harold Austin; *Treasurer,* Dr. T. Grier Miller.

DR. D. P. MORGAN, chemical economist of Scudder, Stevens and Clark, investment counsel, has been made chairman for 1937 of the New York section of the American Chemical Society. He succeeds Dr. Lawrence W. Bass, who resigned recently as director of research for the Borden Company to join the staff of the Mellon Institute of Industrial Research in Pittsburgh. Dr. Duncan A. MacInnes, of the Rockefeller Institute for Medical Research, was elected *vice-chairman,* Dr. Cornelia T. Snell, *secretary,* and C. R. de Long, *treasurer.*

DR. J. B. JOHNSTON, professor of neurology and since 1914 dean of the College of Science, Literature and the Arts at the University of Minnesota, having passed the age of sixty-eight years, will retire at the close of the academic year. He will be succeeded as dean by Dr. John T. Tate, professor of physics, who will take office on July 1.

DR. R. S. HAWKINS has been appointed acting dean of the College of Agriculture and director of the Experiment Station of the University of Arizona, beginning on November 1. He takes the place of Dr. Paul S. Burgess, who was recently elected president to succeed Dr. Homer LeRoy Shantz.

DR. BYRON STOOKEY, associate professor of neurological surgery at the Columbia University School of Medicine, will succeed Dr. Charles Albert Elsberg as chief of neurosurgical service at the Neurological Institute of New York, an affiliate of the Columbia Medical School. Dr. Elsberg, who has been associated with the Neurological Institute since its founding in 1909, will retain his post as professor of neurological surgery in the medical school of the university.

DR. WILLIAM BOYD, professor of pathology in the University of Manitoba, has been appointed professor of pathology in the University of Toronto, to succeed the late Dr. Oskar Klotz.

DR. LEVERING TYSON, director of the National Advisory Council on Radio in Education under the auspices of the Carnegie Corporation, has been elected president of Muhlenberg College.

ARTHUR S. COGGESHALL, chief of the Illinois State Museum, Springfield, has been appointed director of the Santa Barbara Museum of Natural History, California.

DR. C. C. MACDUFFEE, professor of mathematics at the University of Wisconsin, has been chosen man-

aging editor of the *Transactions* of the American Mathematical Society for a period of two years.

PAUL H. ALLEN has been appointed resident manager of the Tropical Station of the Missouri Botanical Garden at Balboa, Panama. He plans to conduct a scientific survey of plant life in Panama and to make collections.

THE Lord President of the council of the British Department of Scientific and Industrial Research has appointed Dr. E. B. Bailey, professor of geology in the University of Glasgow, to be director of the Geological Survey of Great Britain and of the Museum of Practical Geology. Professor Bailey served on the staff of the Geological Survey from 1902 until December, 1929.

D. L. EDWARDS, of Sidmouth, has been appointed director of the Norman Lockyer Observatory at Salcombe Hill, England, in succession to the late Dr. W. J. S. Lockyer. Mr. Edwards joined the observatory staff when the late Sir Norman Lockyer was in charge. The new assistant is D. R. Barber, of Exeter.

PROFESSOR EARLE R. CALEY, of the department of chemistry of Princeton University, has been granted a leave of absence for the second semester in order to establish a field laboratory at the site of the Agora Excavation in Athens, Greece. As a member of the excavation staff he will continue his investigations on the composition, restoration and preservation of ancient materials and objects. This project has been made possible by a grant from the Penrose Fund of the American Philosophical Society.

DR. RICHARD T. COX, associate professor of physics at New York University, will lead an expedition to South America in order to make a study of electric eels in their natural environment. The expedition will make its headquarters at the Goeldi Museum, at Para. Dr. Carlos Estevam, director of the museum, will permit the use of several large pools on the museum premises as proving grounds. Part of the time will be passed at Marajo Island at the mouth of the Amazon.

EMMOT R. BLAKE, assistant curator of birds at the Field Museum of Natural History, sailed from New York for Georgetown, British Guiana, on January 21, to be absent about five months. He plans to collect specimens of the hoatzin, a rare bird, for a proposed habitat group in the museum. On his arrival in British Guiana, he will organize a group of native helpers. The first work will be along the coast, and on the Berbice River, where the hoatzins will be sought. When this is completed, he will proceed into the interior.

DR. SYLVANUS GRISWOLD MORLEY, of the Carnegie Institution of Washington, and Dr. Frans Blom, Maurice Ries and Daniel Leyrer, associates in the department of Middle American research of Tulane University, sailed on separate expeditions for Guatemala on January 13. Dr. Morley will supervise the restoration of a staircase bearing Maya hieroglyphics. Dr. Blom will engage in a six-week expedition through Guatemala on muleback, by airplane and automobile for the International Railroad of Guatemala, to compile data and gather photographs to be used in a book on the country.

DR. ARTHUR H. COMPTON, professor of physics at the University of Chicago, will give the main address at the convocation of the University of Missouri on February 9.

DR. HENRY NORRIS RUSSELL, research professor of astronomy and director of the observatory at Princeton University, lectured on "The Atmospheres of the Planets" in the Dohme series at the Johns Hopkins University on January 2.

DR. DEXTER S. KIMBALL, dean emeritus of the College of Engineering at Cornell University, was guest lecturer at the University of Maine on January 14 and 15. He spoke on "Engineering as a Vocation" before students in the orientation course and delivered two lectures to engineering students on "Administrative Engineering."

PROFESSOR WALTER SCHILLER, of Vienna, who is visiting the United States, gave a Mayo Foundation lecture on January 22 on "New Findings in Ovarian Tumors."

THE departments of geology and geography at Syracuse University and the Institute of Geographical Exploration at Harvard University have arranged a series of exchange lectures. On February 9, 10 and 11, Professor George B. Cressey will deliver a series of lectures at Harvard on the geography of China, and on April 29 through May 1, Professor Erwin Raisz will lecture on cartography at Syracuse.

PROFESSOR NIELS BOHR, director of the University Institute for Theoretical Physics at Copenhagen, is giving lectures in America and will proceed to Japan. On January 28 and 29 he lectures under the auspices of the departments of mathematics, philosophy and physics of New York University. The subjects of the two lectures are "The Structure of Nuclei" and "The Problem of Causality." They will be given at 4:30 in the main building of the Washington Square division. On February 8 and 9, Professor Bohr lectures at the University of Toronto. These lectures are entitled "The General Problem of Measurements in

Atomic Theory," "Transmutations of Atomic Nuclei" and "Light and Life," the last a popular lecture. Professor Bohr will also lecture on "The Problems of Elementary Particles" at the third Washington Conference on Theoretical Physics, held from February 8 to 13 under the auspices of the Carnegie Institution of Washington and the George Washington University.

ON account of the illness of Pope Pius the date for inauguration of the new Pontifical Academy of Science, originally scheduled for February 6, has been changed to May 11.

THE forty-ninth annual meeting of the American Physical Society will be held in Memphis, Tenn., from April 21 to 24. The Hotel Peabody will serve as headquarters for the society, where the meetings of the various sections will be held. Demonstrations, in charge of Dr. O. S. Gibbs, will be made at the College of Medicine of the University of Tennessee. Dr. O. W. Hyman is chairman and Dr. T. P. Nash, Jr., is secretary of the local committee.

A MEETING of the Optical Society of America will be held at Corning, N. Y., on Friday and Saturday, March 5 and 6. Additional sessions may possibly be scheduled for March 4, if warranted by the number of contributed papers. A special feature of the meeting will be the opportunity offered through the courtesy of the Corning Glass Works to see at first hand many applications of optics in the glass industry and the contributions of the glass industry to optics. Of particular interest to members of the society is the manufacture of glasses with special transmission characteristics. Among these products are colored signal glasses, glass for "daylight" lamps, heat-absorbing and ultraviolet transmitting glasses. The Corning Glass Works has cooperated also in the production and standardization of signal glasses for railroad, airplane and automobile transportation.

THE Midwestern Psychological Association will hold its twelfth annual meeting at the University of Illinois, on April 23 and 24, under the presidency of Dr. Harvey A. Carr. The title of Dr. Carr's address will be "The Search for Certainty."

THE first session of the twelfth annual meeting of the Hawaiian Academy of Science was held on the evenings of December 3 and 4 in Honolulu. President Harold A. Wadsworth, professor of soil physics at the University of Hawaii, presided. Ten papers on physics, geology, botany, plant migrations, plant quarantine, plant physiology, population, standards of living and medical science were read.

THE following resolution was adopted by the American Society of Naturalists at the recent Atlantic City meeting: The American Society of Naturalists observes with regret an increasing tendency in certain parts of the world to require of investigators the conformity of their research to officially prescribed doctrines. This society wishes to emphasize that intellectual progress is compatible only with perfect freedom in the conduct of investigation and in the announcement both of results and of conclusions based upon those results. Attention is called also to the fact that the scientific world can place no reliance upon reports of research carried on under conditions which limit its freedom by an enforced agreement with any preconceived views or dogmas.

School and Society prints a communication entitled "Racial Hygiene and the Nobel Prize," signed "Nobel Laureate." It reads: "In a recent Munich paper is a picture of Prof. Dr. med. Alfred Ploetz of Herrsching bei München, who—it is stated—has been proposed for the Nobel Prize on the ground of his researches in Racial Hygiene. It is not stated whether the candidature is in respect of Peace, Literature or Medicine. In the *Münchener Neueste Nachrichten* of November 3, 1936, is an article: 'Nervenwirkstoffe: Zur medizinischen Nobelpreisverleihung,' referring to this year's award of the Nobel Prize in Physiology and Medicine to Sir Henry Dale, of London, and Dr. Otto Loewi, of Graz. The work on 'Vagusstoff' is described, together with the demonstration by H. H. Dale that this is acetylcholine. The name, however, of Dale's colleague in the work and the prize, Otto Loewi of Graz, is altogether withheld. Presumably it would not be in the interests of 'Racial Hygiene,' or perhaps of Dr. Ploetz's candidature, to print it."

WILLIAM A. SARGENT, of Brookline, who died on December 20, bequeathed $300,000 to Amherst College. The sum of $200,000 is left in memory of his mother to be divided between the Massachusetts General Hospital and the New England Deaconess Hospital.

THE *Journal* of the American Medical Association states that Dr. William T. Corlett, professor emeritus of dermatology, Western Reserve University School of Medicine, has furnished and endowed a room in the Cleveland Medical Library dedicated to research in dermatology and syphilology. Dr. Corlett has given his library, which is said to contain many rare items in several languages, and has placed in the room the mahogany furniture used in his office before his retirement. There are also portraits and busts of famous figures in the history of dermatology. Dr. Corlett, who is now eighty-two years old, retired from the faculty of Western Reserve in 1924.

DISCUSSION

A SEX DIFFERENCE ENCOUNTERED IN THE TRANSPLANTATION OF A CARCINOMA OF THE OVARY[1]

A CARCINOMA of the ovary has been continued by subcutaneous transplantation since November 26, 1935.[2] During that time the tumor has been carried through twelve transfer generations. The first experiment consisted of implanting the tumor into one male and three females of the CBA strain—close relatives to the original mouse, which developed the neoplasm spontaneously. Two of the females and the male grew the implanted tissue progressively. In the second transfer generation eight females and four males of the same strain were inoculated with tissue from a mouse in the first experiment. Five of the females and all four of the males grew the tissue. Thus in the first two transfer generations seven out of eleven females grew the tissue, whereas all five of the males grew the implants they received from the same tumor. From the third through the twelfth transfer generations 162 additional mice of the CBA strain have been implanted. Of these 58 were females and 104 were males. One of the 58 female mice inoculated grew the tissue; all the 104 males grew the implant. The one female to grow the tissue occurred in the sixth transfer generation—the significance of which is still in doubt. Thus it appears that since the tissue has been established through two transfer generations it is now capable of growing only in the male mouse. A further genetic and endocrinological analysis of the observed sex difference will be forthcoming.

LEONELL C. STRONG
ROBERT T. HILL

A NEW SOURCE OF DIPHYLLOBOTHRIUM INFECTION

A COLLECTION of tapeworms from the intercostal muscles of *Natrix sipedon* taken near Ithaca, N. Y., on June 18, 1936, was given to the writer by Elmer E. Brown while at the University of Michigan Biological Station.

Recent examination of this material shows it to be a tangled mass of plerocercoids, eighteen in all. Seven complete specimens disengaged from the group range from 22 mm to 186 mm in length, with slit-like bothria which average 0.35 mm long and 0.113 mm wide. The broadest portion of the worms, at a distance of 0.437 mm behind the bothria, measures 1.312 mm. From this point they taper to a width of 0.612 mm at a distance of 0.35 mm from the posterior end. They have all the appearance of plerocercoids belonging to the genus Diphyllobothrium. This I believe to be the first record of a sparganum in snakes in the United States and I designate it as *Sparganum browni* n. sp.

Stiles[1] reported *Sparganum proliferum* from a man in Florida, and Moore[2] records *Sparganum mansoni* from a human case in Texas. Faust[3] found *Natrix tigrina* in the Orient harbored *S. mansoni*. Li,[4] in China, demonstrated other spargana in frogs and snakes to be the plerocercoids of *Diphyllobothrium erinacea* and *D. decipiens*. Recently, Mueller[5] has described *D. mansonoides* from cats in New York state.

Since *Natrix sipedon* is a great fish eater, a systematic examination of this snake and small fish from streams in the vicinity of Ithaca and Syracuse, N. Y., might disclose the source of the infection of water snakes with this sparganum. Live plerocercoids from such a source fed to cats may prove it to be *Diphyllobothrium mansonoides*, *D. mansoni* or a new species.

LYELL J. THOMAS
UNIVERSITY OF ILLINOIS

THE EFFECT OF LIGHT ON THE VITAMIN C OF MILK

THE interesting article on vitamin C in pasteurized milk by Professor Sharp[1] prompts me to describe here very briefly the results of the work on the vitamin C of milk which has been carried out at our institute during the last few years. A full account of the work[2] will appear in the last number of the current volume of the *Biochemical Journal*. I think, however, that a summary of the salient points will not be amiss here, because I believe that our observations provide a satisfactory explanation of several problems raised by Professor Sharp. They are also, I hope, of general interest.

In estimating vitamin C chemically in milk by the method of Birch, Harris and Ray,[3] I[4] observed very marked fluctuations in the concentration of that vitamin from day to day. The possible causes of this phenomenon were investigated by Mattick and myself,[5] who ultimately found that milk which originally gave a positive vitamin C titration failed to reduce the indophenol reagent after a short exposure to light in

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[1] From the Department of Anatomy, Yale University School of Medicine. Aided by grants from the International Cancer Research Foundation and the Anna Fuller Fund. Acknowledgment is made to the Fluid Research Fund of Yale University.

[2] "Endocrinology" (in press).

[1] C. W. Stiles, *U. S. Hyg. Lab. Bull.*, 40: 1–18, 1908.

[2] J. T. Moore, *Amer. Jour. Trop. Diseases*, 2: 518–525, 1915.

[3] E. C. Faust, "Human Helminthology," 1929.

[4] H. C. Li, *Amer. Jour. Hyg.*, 10 (3): 527–550, 1929.

[5] J. F. Mueller, *Jour. Parasit.*, 21 (2): 114–121, 1935 and 22 (5): 471–478, 1936.

[1] SCIENCE, 84: 461, 1936.

[2] By S. K. Kon and M. B. Watson.

[3] *Biochem. Jour.*, 27: 59, 1933.

[4] S. K. Kon, *Nature*, 132: 64, 1933.

[5] *Nature*, 132: 446, 1933.

glass bottles. Some time later Booth and Kon[6] showed that the power to reduce the reagent could be restored to an extent varying with the length of exposure to light by treating the milk with hydrogen sulfide. The further detailed study by Kon and Watson yielded the following information:

Under the action of light the ascorbic acid of milk undergoes reversible oxidation, most probably to dehydroascorbic acid. Visible light of short wave-length (blue and violet) is mainly responsible for the reaction. Ultra-violet light is also probably active, but yellow and red are almost without effect. The action of light does not take place in the absence of oxygen, and the reversible oxidation follows the laws of a unimolecular reaction. The reversibly oxidized product is biologically active. The product suffers further decomposition spontaneously, without the agency of light, giving a substance which fails to decolorize the indophenol reagent even after treatment with H_2S and is devoid of biological activity. This reaction does not run to completion. Synthetic ascorbic acid added to milk behaves, under the action of light, in the same way as the ascorbic acid originally present.

Pasteurization by the holder method destroys the reversibly oxidized, but does not affect the reduced, form of ascorbic acid in milk. Milk, as secreted by the normal cow, contains only reduced ascorbic acid. The amount of destruction of vitamin C caused by pasteurization in the absence of catalytic metals (copper) depends on the previous exposure of the milk to light.

S. K. KON

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING
UNIVERSITY OF READING, ENGLAND

FISH IN THE LATAH FORMATION OF IDAHO

THE purpose of this notice is to bring to the attention of vertebrate paleontologists the existence of fish skeletons in the Latah formation.

In May, 1936, Dr. R. L. Lupher conducted a field trip along the Clearwater River for his class in historical geology. The writer was very pleased to accompany the class as a guest. One of the stops was at a road cut, on the north bank of the river, eleven and one half miles east of Lewiston, Idaho, in T. 36 N., R. 4 W., Boise Meridian. This seems to be the collecting locality called Station 4 by Kirkham and Johnson,[1] who found at least twelve species of plants, which were later described by Berry.[2] Here the Latah beds strike N. 85° W. and dip 20° W. They are composed of yellow and porcelaneous white shale with an eight-inch bed of gray volcanic ash passing through the center of the outcrop.

Fragmentary remains of fish were found by several members of the party. Messrs. J. Bone, A. O. Huhn, M. Morsing and J. Storall uncovered three complete skeletons, which they kindly presented to the writer. Since the first discovery the writer has visited the outcrop twice and both times has found fish remains. The skeletons are from four to six inches long and have been determined temporarily as belonging to the genus *Leuciscus*. Accurate determinations, as yet, have not been made. One slab, measuring ten inches by fourteen inches, has yet to be uncovered.

Dr. F. B. Laney[3] has found bone fragments, and Berry[2] has noted occasional scales, spines and bones in the Latah formation; but, so far as the writer is able to ascertain, this is the first discovery of complete and articulated fish skeletons. Although these skeletons are from only one locality in Idaho, the writer is confident, because of the fine grain of the clay-shale and the excellent preservation of plant remains, that more diligent collecting will uncover many such skeletons in the Latah formation of both Idaho and Washington.

VERNON E. SCHEID

UNIVERSITY OF IDAHO

THE PROTECTION OF PLANTS

RECENT experience[1] shows that the effect of poison-sprayers (arsenic, copper, lead, etc.) is found to extend much beyond its immediate objective, namely, the protection of crops against parasitic attacks.

Apart from its inability to discriminate between friend and foe, this treatment represents in its cumulative poisoning action upon the soil a grave danger to future plant life both by (a) its inhibition of growth and (b) the introduction of toxic constituents into plant metabolism. A greater stress upon the augmentation of the plant's natural means of protection, such as sanitation, nutrition and stock selection, might perhaps lessen the recourse to these artificial protective means.

Now from the work of Greenbank[2] on the inhibition of rancidity in fats and oils (with a possible extension to cereals) by maleic acid, and that of Copisarow[3] on (a) the bactericidal and fungicidal properties of maleic acid, (b) the close chemical and physiological resemblance, if not identity, of maleic acid with the natural

[6] *Nature*, 134: 536, 1934.

[1] V. R. D. Kirkham and M. M. Johnson, *Jour. Geology*, 37: 483–504, 1929.

[2] E. W. Berry, *U. S. Geol. Survey Prof. Paper 185*, pp. 97–125, pls. 19–24, 1934.

[3] Oral communication.

[1] Report of the American Society of Plant Physiologists, Western Section, SCIENCE, 84: 171, 174, 1936.

[2] Greenbank, U. S. Pat., 1898, 363, Feb. 21, 1933; SCIENCE, 77: *Suppl.*, page 6, February 24, 1933.

[3] Copisarow, *Jour. Pom. Hort. Sci.*, 14: 9, 1936.

inhibitor—"blastokolin"—present in fruit and vegetables[4] and (c) the probable transition of this inhibitor into the natural accelerator (ethylene), a transformation marking the ripening stage in fruit development and expressed chemically by the degradation of maleic acid to ethylene and carbon dioxide—it appears that the substitution of the poison-sprayers by the natural inhibitor may constitute a practical means of assisting the plant's self-protection. As in the case of stored fruit and vegetables spraying with a solution or emulsion of maleic acid in ethereal oil, paraffin, solvent naphtha or some other suitable medium may perhaps be found effective for such plant treatment.

The application of maleic acid may extend not only to bacteria and fungi, but also to insects in the early stages of their metamorphosis. Again the presence of the inhibitor in seeds and its ready diffusion in an aqueous medium[4] suggests the possibility of treating the seeds with maleic acid as an anti-virus measure. It is perceivable that the preferential cultivation of barbless, husk-free, thin-skin, etc., varieties eliminates the hardier types in our crops, as the accelerated elution of the free, or hydrolysis of the combined inhibitor (as in the case of vitamin C[5]) exert a disturbing influence both on the enzymic equilibrium and general metabolism and increases the susceptibility to parasitic attacks.

The controlled use of maleic acid would obviate any appreciable interference with the normal course of metabolism or any ill effect on food values.

MAURICE COPISAROW

RESEARCH LABORATORY
145 ALEXANDRA ROAD
MANCHESTER, 16, ENGLAND

SCIENTIFIC BOOKS

RATIONAL FUNCTIONS

Interpolation and Approximation by Rational Functions in the Complex Domain. By J. L. WALSH. American Mathematical Society Colloquium Publications, Volume XX, 1935.

IN the field of approximation by rational functions in the complex domain the author of this monograph has been among the most active and successful investigators during more than the last half-score of years. His contributions have been widely read, and his authority in the subject is generally recognized. It would be surprising under these circumstances were his book to be found anything but a valuable and significant addition to the mathematical literature. There is no cause for such surprise. Professor Walsh has written here a clear, careful, thorough and scholarly account which will not fail to receive general commendation. The book is a worthy addition to the important series of Colloquium Publications of the American Mathematical Society.

The subjects of interpolation and approximation, if their many aspects and ramifications are included, are too vast by far to admit of detailed treatment in any single volume. The present monograph confines itself, therefore, specifically to sequences of polynomials or general rational functions which are determined in one of the following two ways; *i.e.*, by the fact that they coincide with (interpolate) a given function upon an assigned set of points or by the fact that they lie closest to (approximate) the given function in a certain specific sense. The considerations are made entirely in the complex domain, the given function being usually assumed to be analytic. Topics pertaining immediately to the real variable are given no place here. It will be clear from this that the author has restricted his book to those aspects of the subject which have been centers of his own research. This, of course, is entirely in the tradition of this series of publications.

Of the field considered the book gives a thorough and comprehensive treatment, generally with an ample degree of detail. Many results of the author's which are included here have not heretofore been published. The material, as one would expect, is technical to a high degree and requires, therefore, to be read closely and with care. There is much of it. However, its organization, which could have been no simple problem, has been effectively and skilfully carried out. The work is well documented—the bibliography including some 150 titles.

In point of style and arrangement there is much similarity with that of the author's recent essay, "Approximation by Polynomials in the Complex Domain," Memorial des Sciences Mathematiques, Paris, 1935, wherever that essay and the present monograph deal with the same material. The monograph, however, in distinction from the essay, is a systematic exposition, not an outline, and among other things deals with general rational functions as well as with polynomials.

In brief summary the contents of the twelve chapters of the book may be described somewhat as follows: In the early chapters general function theoretic considerations and the basic theorems on approximation are set forth, and are followed by discussions and theorems on series of interpolating polynomials—Jacobi series—

[4] Kockemann, *Ber. Deut. Bot. Ges.*, 52: 523, 1934; Shuck, SCIENCE, 81: 236, 1935.

[5] Levy, *Nature*, 138: 933, 1936.

lemniscate curves—conformal mapping—the convergence, overconvergence and maximal convergence of sequences of polynomials. There follow in the next chapters discussions of polynomials of approximation best in the sense of Tchebycheff, or in the sense that they minimize suitable integrals—of orthogonal polynomials and their theory—of polynomials of interpolation in uniformly distributed points—and some comparative study of the properties of interpolation and of approximation. The later chapters, finally, deal with formulas for rational functions of interpolation and sequences of such functions—the principle of duality—approximation by means of rational functions—auxiliary conditions—and the existence and uniqueness of rational functions of best approximation.

It was the author's expressed purpose to write a book which would serve both the novice in the subject and the specialist. The beginner, who would necessarily have familiarity with the general theory of functions of a complex variable, will find the book a very readable one which greatly facilitates an introduction to the subject. The specialist will find the book indispensable. Both will thank Professor Walsh for his work.

RUDOLPH E. LANGER

REPORT OF THE ASSOCIATION OF GEODESY

Travaux de l'Association de Géodésie de l'Union Géodésique et Géophysique Internationale, Tome 12, publié par le Secrétaire, Georges Perrier. Rapports généraux établis à l'occasion de la Cinquième Assemblée Générale, Lisbonne, 14–25 Septembre, 1933. vi + 552 pp., 4to. 180 francs. Paris, au Secrétariat de l'Association, 1935.

THIS volume comprises eight different reports, each with its own independent paging, on various aspects of geodesy and in five different languages. It would be impossible to summarize its contents or to comment on them with any profit to the reader, so it seems best to take the space ordinarily occupied by detailed summaries and comments for some explanations about the history of the organization issuing this volume.

Before the world war there was an International Association of Geodesy, devoted to geodesy alone. When it was founded in 1862 by General Baeyer, it included only some of the German states and neighboring countries of Europe, but it soon became international in scope. Its triennial conferences were held at various places in Europe. The last of these was at Hamburg in 1912. The world war broke up this international scientific organization, as it broke up others, although a "Reduced Geodetic Association of Neutral Nations" survived the world war and maintained one of the principal cooperative international enterprises of the old association, the International Latitude Service, established in 1899 to study the variation of latitude.

After the war, however, this reduced association did not expand to the original dimensions of the old association but, after some hesitation, merged its activities with those of a new organization that tried to put in practice the idea that geodesy is but one branch of earth-science and has therefore close relations with other branches of earth-science, all of which are included in the general term "geophysics." The word "geophysics" has also acquired the special meaning of the use of physical methods to determine subsurface structure for strictly commercial purposes; this special meaning does not concern us here.

In 1919 there was organized at Brussels an International Union of Geodesy and Geophysics with several divisions, first termed sections and later associations, of which the Association of Geodesy, which issues this volume, was one. The other associations deal with seismology, physical oceanography, terrestrial magnetism, meteorology, hydrology and volcanology. One purpose of the Union was to emphasize the points of contact between these different branches of earth-science and to facilitate the intercourse among workers in them. Like most other purposes, however, it has been realized only imperfectly.

Another less laudable purpose seemed to be to keep the Germans and their allies in the war out of the organization. The wording of the statutes was such as to discourage their admission. This wording was changed, however, in 1926 with the effect of bringing some of Germany's allies into the Union, but at this writing and as far as the reviewer knows, neither Germany itself nor Austria.

Since its organization the Union and its associations have held general assemblies at Rome (1922), Madrid (1924), Prague (1927), Stockholm (1930), Lisbon (1933) and Edinburgh (1936). The next meeting is scheduled for Washington in 1939.

The Association of Geodesy issues three regular series of publications, the *Bulletin Géodésique* (quarterly), the national reports presented to various general assemblies and special reports on various subjects. The *Bulletin Géodésique* is a journal containing articles of scientific interest, news notes, official announcements, etc. The national reports presented to each assembly cover the activities of the various member nations since the preceding assembly. Each nation speaks for itself and prints its own report in its own way but on pages of uniform size. These separate reports, bound together and supplied with a cover, constitute the volume of national reports. The special reports, of which the volume under review is one, are

prepared by specially designated reporters for various subjects. These reports try (*try* is the proper word, as the reviewer knows and as may be read in so many words or between the lines in the reports themselves) to cover the progress in the designated subject for the three years preceding. The present volume contains the following reports intended for the Lisbon meeting and covers the calendar years 1931–1933, inclusive:

"Precise Leveling," J. Vignal and R. Taton (France). 155 pages.
"Latitude, Longitude and Azimuth and Geodetic Applications of Wireless Telegraphy," H. L. P. Jolly (Great Britain). 144 pages.
"Deflections of the Vertical," K. Wold (Norway). 27 pages.
"Gravity on Land," E. Soler (Italy). 107 pages.
"Gravity at Sea," F. A. Vening Meinesz (Netherlands). 11 pages.
"Isostasy," W. Heiskanen (Finland). 51 pages.
"Projections," H. Roussilhe (France). 38 pages.
"Earth Tides," W. D. Lambert (U. S. A.). 19 pages.

Triangulation and base measurement seem obvious omissions, for they are the backbone of geodesy, but there were difficulties in completing r[illegible] on these subjects and a full report is promised for a later date, to include the data submitted for the General Assembly at Edinburgh in 1936. The report by Kimura on the variation of latitude is included in the national report of Japan.

There is much of interest and value in these reports, but detailed comment would take much space and would require the concentration of an unusual amount of specialized knowledge in one reviewer. The manner of treatment is as varied as the subjects and the nationality of the reporters. Two general comments suggest themselves:

(1) One purpose of the Association is to attain some degree of uniformity in notation, nomenclature and methods of procedure. It might be feared that this desired uniformity would in time be overdone, but these reports afford no indication that this fear is justified.

(2) Geodesy is an old science, dating, let us say, from the time of Eratosthenes (200 B.C.), but it is far from being a finished body of doctrine. There are plenty of problems still awaiting solution.

WALTER D. LAMBERT

SPECIAL ARTICLES

STIMULATED ACTIVITY OF NATURAL ENEMIES OF NEMATODES[1]

SOROKIN,[2] Zopf[3] and others long ago recorded the [des]truction of nematodes by fungal parasites or by [fun]gi which trap nematodes with specialized organs [of c]apture, then penetrate and consume them. Re[centl]y, Drechsler[4,5,6] has added greatly to the list of [nema]-capturing fungi and to an understanding of their [mea]ns of capture.

[M]any of the nema-capturing fungi grow freely as [sap]rophytes, most of them produce aerial conidia, and [sev]eral are also disseminated by the movement of [ne]natodes carrying detached fragments of fungus. [M]ost of them appear relatively non-specific, capturing [n]ematodes of several genera apparently with equal [eas]e. Likewise, at least some of the non-trapping [par]asites are non-specific, but others may attack only [cert]ain genera or related genera of nematodes.

Most of the fungi reported by Drechsler have thus far been reported only from the vicinity of Washington, D. C. *Arthrobotrys oligospora* Fresenius and several parasites, however, have been recorded from various parts of Europe. The lack of more numerous reports probably results from lack of adequate search with appropriate techniques.

Since October, 1935, the writer and associates have recognized over 20 nema-destroying fungi, including simple parasites and trappers in Hawaiian field, garden and forest soils. Many of them destroy larvae of *Heterodera marioni* (Cornu) Goodey as readily as they do nematodes formerly reported to be attacked. A very superficial survey has shown certain of them to be wide-spread in the Hawaiian Islands. One or more has been found in every old pineapple field thus far sampled adequately, while a plot of approximately two acres which has been sampled more intensively yielded 15 distinct forms. Several of these appear identical with forms described elsewh[ere], [in]cluding *Arthrobotrys oligospora* Fresenius, *[…] anguillulae* Sorokin, *Harposporium anguill[ulae]*, *Stylopage hadra* Drechsler and forms [apparently] identical with Drechsler's[7] numbers, 4, [...] 15. Several others appear to be un[described]. Even in the plot in which 15 sp[…]

[1] Published with the approval of the director as Technical Paper No. 94 of the Pineapple Experiment Station, [Univ]ersity of Hawaii.
[2] Sorokin, *Ann. d. Sci. Nat. Bot.*, Ser. 6, 4: 62–71, [...]
[3] Zopf, *Nova Acta Ksl. Leop.-Carol. Deutschen Naturforscher*, 47 (4): 167–168, 1884; 52 (7): 1, 1888.
[4] C. Drechsler, *Jour. Washington Acad. Sci.*, 23: 138–141, 267–270, 355–357, 1933.
[5] C. Drechsler, *Mycologia*, 26 (2): 135–144, 1934.
[6] C. Drechsler, *Mycologia*, 27 (2): 206–215, 1935.
[7] See footnote 4.

found, th... t knot nematode, *Heterodera marioni*, is still securely established, although less abundant than in some other pineapple fields. Apparently, extermination of plant parasitic nematodes by such fungi is not to be expected. Laboratory and glasshouse experiments have, however, demonstrated the possibility of so increasing the activity of these fungi that they assume some practical significance in control of *H. marioni*.

Incorporation of fresh plant material into soil is followed by a rapid rise in the total population of free-living nematodes. A 65-fold increase was recorded after 14 days in one experiment, with *Aphelenchus avenae* Bastian, *Aphelenchoides parietinus* Bastian, *Cephalobus* spp., and *Rhabditis* spp. all abundant. Parasites and trappers were conspicuous in association with these nematodes when washed from the soil for counting. Within 21 days the nematode population was greatly reduced and nema-destroying fungi were still more conspicuous. Such fungi included at least 3 trappers and 2 non-trapping parasites. Ample confirming evidence establishes the fact that as the total nematode population increases, the natural enemies of nematodes so increase their activity that the multiplication of nematodes, favored by an abundant food supply, is overbalanced.

During a period of such increased activity of nema-destroying fungi, one might expect the larvae of obligate plant-parasitic nematodes, unable to reproduce under these conditions, to be reduced in numbers. Experiments have demonstrated this to be the case with *H. marioni*.

In a series of laboratory and glasshouse tests, chopped pineapple plant material has been mixed with naturally infested field soil and allowed to decompose

TABLE I

REDUCTION OF POPULATIONS OF INFECTIVE LARVAE OF *Heterodera marioni* IN NATURALLY INFESTED SOIL DURING DECOMPOSITION OF CHOPPED PINEAPPLE PLANT MATERIAL, MEASURED BY GALL COUNTS ON WHIPPOORWILL COWPEA INDICATOR PLANTS

Experiment ·o.	Rate* of application	Duration of decomposition (weeks)	Fre-† quency of mixing (weeks)	Galls per 2400 g. soil	
				Check	Decomposition
	200	12	1	611 ± 46.5	2.0 ± 0.8
	200	12	1	190 ± 14.0	27.0 ± 5.3
	150	12	1	"	21.0 ± 3.0
	·0	12	1	"	31.0 ± 5.0
	0	12	1	"	66.0 ± 15.3
		12	3	1415 ± 153.5	98.0 ± 13.2
		12	1	1036 ± 93.5	90.0 ± 11.5
		4	2	7814 ± 525.3	425.0 ± 62.0
		8	2	2229 ± 237.6	609.0 ± 63.4
		·2	2	5297 ± 431.8	982.0 ± 173.8

equivalent of the amounts actually
·es of soil.
mild shaking of the soil jars.

under favorable conditions of temperature and moisture during various periods of time prior to the measurement of surviving populations of infective larvae by the indicator plant method. The soils thus far used are from pineapple fields in two localities on the island of Oahu. Summarized results are presented in Table I.

In each instance the check soil was held under laboratory conditions during the period allowed for decomposition in the treated soils, with no host plants present. Striking reductions in populations of infective larvae have been observed in every experiment. Statistical treatment, following Miles,[8] based on standard error of difference, shows odds greater than 1999 : 1 for every comparison of decompositon and check in Table I. No less significant results have yet been obtained.

Pineapple plant material was used in these experiments, since in Hawaiian pineapple fields at the end of three to four years' growth, the amount of plant material to be disposed of prior to replanting frequently exceeds 100 tons and sometimes 150 tons per acre. Current practices involve decomposition of this material in place, chiefly on the soil surface, with gradual incorporation into the soil. The effects of th· field handling and of more prompt plowing und upon nematodes are still undetermined.

Corresponding results follow decomposition of ot plant materials. For example, data not included Table I were obtained in Experiment 1 following application of grass (*Panicum barbinode*) at a r equivalent to 165 tons per acre-foot. This exces application was for comparison with approxima equal dry matter in 200 tons pineapple per acre. check was the same as shown in Table I, Experime with 611 ± 46.5 *H. marioni* galls per jar of After decomposition of grass, the gall count 16.5 ± 2.9. This reduction, though not quite equa that obtained with pineapple in this experiment, s has enormous statistical significance.

The mechanism of stimulated activity of natu enemies of nematodes reported here may have been factor in the beneficial results attributed by vari investigators to green manures on Heterodera-infes soils, for this mechanism may be expected to red soil populations of obligate plant-parasitic nemat larvae generally where effective nema-destroying fu occur and where sufficient organic matter is ir porated into the soil to build up a heavy popul of free-living nematodes.

M. B. LINF

PINEAPPLE EXPERIMENT STATION
HONOLULU, T. H.

[8] S. R. Miles, *Jour. Amer. Soc. Agron.*, 26: 341–346, 1934.

SEX VARIATIONS IN THE UTILIZATION OF IRON BY ANEMIC RATS

THE finding that all compounds of iron are not equally effective in the remission or prevention of nutritional anemia even in the presence of ample copper has led to an increased interest in the determination of iron availability.[1,2] The accepted method for measuring the amount of iron in a foodstuff which is utilizable for hemoglobin formation consists, briefly, of feeding the food of analyzed iron content, with copper, to anemic rats upon a whole milk diet and comparing the hemoglobin response with that obtained from anemic rats given the same amount of iron as ferric chloride.

In the course of investigation in this laboratory of the hematopoietic value of foodstuffs by this method, a marked difference in response between male and female rats has been consistently noted. As it has been customary to use males and females interchangeably in other laboratories, the effect of a sex difference upon the accuracy of the results obtained seemed worthy of investigation.

EXPERIMENTAL PROCEDURE

The technique used for the preparation of the anemic rats used in the test was essentially that of Elvehjem and Kemmerer.[3] When young rats were two weeks of age the stock colony ration provided for the mothers was replaced by whole-milk powder (Klim). During the third week of age, therefore, the young had access to milk only. The mothers were separated from their young for several hours each morning and allowed to eat as much of the stock colony whole wheat and milk ration as they desired. They were then carefully brushed and returned to their young. When three weeks of age the young were weaned and continued on whole-milk powder as sole food.

Blood samples were taken from the tail at weekly intervals, and the hemoglobin content was determined by comparison with a standard Newcomber plate in a Duboscq colorimeter. By the fourth or fifth week the hemoglobin level of rats in this laboratory prepared in the fashion described above fell to an average of 3.9 (range 2.9 to 4.5) grams per 100 cc of blood. At this time the animals were placed in individual galvanized iron cages with raised screen bottoms. The whole-milk powder which served as the basal diet and distilled water were provided *ad libitum* in glass containers.

The iron supplements or foods under test were fed separately for a subsequent test period of six weeks duration. Throughout the test period, .05 mg Cu as $CuSO_4$ and .04 mg Mn as $MnCl_2$ were given daily. The course of hemoglobin regeneration was followed by hemoglobin measurements made at two-week intervals. The comparative hemoglobin responses of males and females to iron supplements of the same magnitude, given as $FeCl_3$ or a food, appear in Table I,

COMPARATIVE HEMOGLOBIN REGENERATION IN MALE AND FEMALE RATS

Supplement fed daily	6 weeks gain in Hb (gms per 100 cc)	
	Males	Females
.01 mg Fe as $FeCl_3$	1.0	2.3
.05 " " " "	2.9	4.2
.1 " " "	5.5	6.5
.2 " " "	9.1	10.9
.25 " " " "	10.4	10.7
.3 " " " "	10.1	10.2
3 gms whole wheat	7.7	9.1
3 " rolled oats	5.7	7.0
1.5 gms dried lima beans	4.8	6.1

which records the gains in hemoglobin concentration during the six weeks test period. At least 10 males and 10 females were used on each level of iron.

It may be seen that hemoglobin regeneration was greater in the females than in the males fed the same amount of iron or given the same amount of an iron-bearing food. This difference between the sexes was consistently noted among litter mate rats except at levels of iron feeding greater than .2 mg daily. At daily iron levels of .25 mg and above, the iron intake was sufficiently high to promote maximum hemoglobin development in all the rats of this age so that a difference between the sexes in the rate of gain of hemoglobin could not be expected. That the observed differences are significant is indicated by the fact that the experimentally obtained differences are from three to six times greater than the probable errors of these differences.

The explanation of this difference in response may lie in the greater store of iron in the female[4] which becomes available for hemoglobin formation upon the giving of copper. This view is substantiated by the finding that the difference between male and female response was not observed after two weeks of the supplemental feeding and also by the fact that the difference is approximately the same at all levels of iron supplementation. The original hemoglobin level of all the males discussed in this paper was 3.8 gms per 100 cc of blood as compared with a level of 3.9 gms in the females at the beginning of the test period. Thus a difference [illegible]n reserve supply of iron in the males and

[1] C. E. Elvehjem, E. B. Hart and W. C. Sherman, *Jour. Biol. Chem.*, 103: 61–70, 1933.

[2] W. C. Sherman, C. A. Elvehjem and E. B. Hart, *Jour. Biol. Chem.*, 107: 383–394, 1934.

[3] C. A. Elvehjem and A. R. Kemmerer, *Jour. Biol. Chem.*, 93: 189–195, 1931.

[4] M [illegible]artz Rose and Lan-Chen Kung, *Jour. Biol. C[illegible]* [illegible]17–437, 1932.

females was not indicated by a significant difference in hemoglobin concentration of the blood at the beginning of the test period. Elvehjem[3] has stressed the necessity of exhaustion of body iron stores in preparation of test animals, and the question arises as to what evidence of exhaustion can be accepted. Allowing the hemoglobin level to fall too low results in animals which are sickly and not capable of a normal response to the iron supplement given subsequently.

Whatever is the explanation of this greater hemoglobin regeneration in anemic female rats as compared with males, it is the authors' belief that ignorance of this fact may explain some of the discrepancies of the same magnitude in the findings in various laboratories relative to the availability of iron in foodstu'

MARGARET CAMMA ... H
LOUISE OTIS ... PO..
UNIVERSITY OF ARIZONA

A CATALYTIC METHOD FOR THE PREPARATION OF α-PYROABIETIC ACID

THE preparation of the so-called pyroabietic acids by the usual prolonged high temperature treatment of rosin[1,2] entails very considerable pyrolytic decomposition, with consequent contamination of the resulting product. In connection with recent experiments on dehydrogenation of rosin products (rich in pimaric acids), by way of palladium charcoal,[3] it was noted that an appreciable proportion of a positive rotating acid survived the high temperature (300–325° C.), a region normally well above that at which decarboxylation of rosin acids takes place. The isolated acid did not give a crystalline sodium salt characteristic of α-pimaric acid, nor did it have its optical properties.[4] Its melting point (171–172° C.), rotation ($[\alpha]^{20}_{d}+54°$; $[\alpha]^{20}_{j}+58°$) and other properties agree well with those of α-pyroabietic acid described by Dupont-Dubourg, Fanica and others. Subsequent experiments with the palladium charcoal catalyst showed that the isomerization can be carried out at much lower temperatures (250° C.) and completed in about two or three hours. The yield at the lower temperature is excellent, the product quite uniform and apparently unaccompanied by the usual intermediate isomers. Acids with the same properties were obtained with this catalytic procedure from α-pimaric acid, l-abietic acid (Schulz), mixed rosin acids and rosins from longleaf and slash pines (*Pinus palustris* and *Pinus caribaea*) and French gum (*Pinus pinaster*). This finding, which would indicate highly selective isomerizing action for the catalyst, is in marked contrast with results obtained by the usual 100-hour heating without a catalyst when applied to rosin acids and rosins from different sources.[2]

Preliminary experiments showed that palladium charcoal catalyzes the isomerization even at 200° C., but not as effectively as at higher temperatures. Platinum charcoal, nickel charcoal and, to a lesser extent, activated charcoal itself also catalyzed the formation of pyroabietic acid.

This laboratory is at present engaged in a systematic study of the application of various catalysts and different types of carriers to the primary rosin acids, as well as the rosin acids or partially isomerized acids. Publication of more comprehensive data is contemplated in the near future.

ELMER E. FLECK
S. PALKIN
BUREAU OF CHEMISTRY AND SOILS
U. S. DEPARTMENT OF AGRICULTURE

[1] Dupont and Dubourg, *Bull. Inst. Pin.*, 51: 181, 1928.
[2] Fanica, *Bull. Inst. Pin.*, 44: 155, 1933.
[3] Method of Ruzicka and Waldman, *Helv. Chim. Acta*, 16: 842, 1933.
[4] S. Palkin and T. H. Harris, *Jour. Am. Chem. Soc.*, 55: 3683, 1933.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

PRESERVING THE NATURAL COLOR OF GREEN PLANTS[1]

IMPROVED teaching methods of botanical subjects demand better demonstration materials. Living specimens should be preferred to non-living ones. However, increased difficulties in obtaining living specimens forces the use of more preserved forms. Better methods of preservation are needed to increase attractiveness of dead specimens. Several methods have been published which are more or less useful. Keefe's[2] method is outstanding among these. The writer has experimented with older formulae as well as new combinations for a period of about three years. Out of this work success with one new, general method seems to justify publication.

Formalin-acetic acid-alcohol solutions (5 cc of commercial formalin, 5 cc of glacial acetic acid and 90 cc of 50 per cent. ethyl alcohol; or 10 cc of commercial formalin, 5 cc of glacial acetic acid and 85 cc of 70 per cent. ethyl alcohol) are in general excellent preservatives. They are being used extensively for museum and histological materials. By adding 0.2 gram of copper sulfate to 100 cc of either of these F.A.A. formulae, a preservative results which will bring about an almost normal green color in nearly all

[1] Papers from the Department of Botany, ... State University, No. 383.

[2] Keefe, Anselm Maynard. SCIENCE, 64: 331–332, 1926.

chlorophyll-bearing plant organs. It is not necessary to weigh the copper. A stock of the preservative may be saturated by adding an excess, and the remaining undissolved copper removed, or a lump may be dropped in the preservative along with the specimens and left until proper color fixation occurs. When the latter method is employed the specimens should be shaken after standing a few hours to insure complete distribution of the copper. Successful results also may be obtained even if the copper is not added for six to eight hours after the specimens enter the solution. Some difficulty may be experienced, especially with certain algal cultures in which excess carbonates are present. A bluish-white precipitate (probably copper carbonate) may accumulate if excess copper is added and allowed to remain. Removal of the extra copper after saturation prevents much of this. Ordinarily the usual discoloration occurs soon after specimens enter the preservative, but after three to four days in the F.A.A.-copper sulfate solution usually a green color appears. By watching development of its intensity and removing specimens when the proper color is obtained, excellent specimens may be secured. They are transferred then to a copper-free F.A.A. solution, 70 per cent. alcohol or other preservatives for permanent storage. In a few plants, such as *Berberis* and *Ophioglossum*, some difficulty may be experienced in obtaining sufficient penetration for rapid development of the proper green color. However, if such specimens are boiled in the preservative for fifteen to twenty minutes good results follow. Care must be taken to stop the heating when coloration has developed to the proper point, and to transfer specimens to a copper-free solution. This quick method may be employed wherever heating is not injurious to the plants.

The color reaction may also be hastened by exhausting air from tissues immediately after specimens enter the preservative. This can be done easily by means of the common vacuum pump which is run by water-supply pressure. This is especially usable for fern gametophytes and young sporophytes. In these two cases permanent coloration can be obtained within fifteen to thirty minutes. Thicker tissues should be allowed to stand in the copper solution for a day or so after air exhaustion.

The addition of copper sulfate to Transeau's Algal Preservative also gave similar results as for the above. Dr. E. N. Transeau developed this preservative over twenty years ago. It is an excellent preservative for algae as well as for general preservation. The formula calls for 6 parts water, 3 parts 95 per cent. ethyl alcohol and 1 part commercial formalin. If marine algae are to be preserved sea water is used in making up the solution. After fixation has occurred, 5 to 10 per cent. glycerine may be added to prevent destruction of algal specimens in case of loss of preservative by evaporation.

Several tissues preserved in F.A.A.-copper sulfate solution have been sectioned and stained. Cellular structure is preserved the same as for straight F.A.A., and no apparent difficulty in staining has been encountered. The copper sulfate even enhances differentiation in some cases. This may be due to the copper salt rendering the tissues more acid. The green color can not be held with sufficient intensity to permit use in the Venetian Turpentine Method without further staining. Efforts in this direction have been made, using fern gametophytes and moss protonemata.

The chief advantages of this method and its modifications are: (1) a green color closely approximating that of ordinary chlorophyll is obtained; (2) preservative ingredients are easily secured and inexpensive; (3) the method is rapid; (4) fixation is sufficiently good for many histological problems; (5) color fixation does not interfere with staining; (6) and the preservative gives successful results with numerous representatives of Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.

GLENN W. BLAYDES

THE OHIO STATE UNIVERSITY

A MODIFIED QUINHYDRONE ELECTRODE FOR TISSUES[1]

THE quinhydrone electrode has enjoyed extensive use in the determination of the pH of physiological systems. Its reliability in solutions containing proteins was investigated extensively by Shau-Kuang Liu[2] in 1927. Recently, Pierce[3] and Pierce and Montgomery[4] developed a micro-modification of the Cullen[5] electrode and used it successfully to determine the pH of the glomerular urine of Necturus and the aqueous humor of rachitic rats. With this type quinhydrone electrode the broken skin of the animal in contact with the saturated potassium chloride solution completes the junction of the two half cells. To avoid this, which gives rise to erratic potentials with the intact skin and practical difficulties with the broken skin, the following modification of the quinhydrone electrode was designed and found serviceable in tumor tissues where sufficient fluid was present to fill the capillary.

With this quinhydrone electrode a series of Hastings[6] and Sendroy's phosphate buffer mixtures was measured at 20° C.

[1] The expense of this work was defrayed in part by a grant from the International Cancer Research Foundation.

[2] Shau-Kuang Liu, *Biochem. Z.*, 185: 243, 1927.

[3] J. A. Pierce, *Jour. Biol. Chem.*, 111: 501, 1935.

[4] J. A. Pierce and H. Montgomery, *Jour. Biol. Chem.*, 110: 763, 1935.

[5] G. E. Cullen, *Jour. Biol. Chem.*, 83: 535, 1928.

[6] A. B. Hastings and J. Sendroy, *Jour. Biol. Chem.*, 61: 695, 1924.

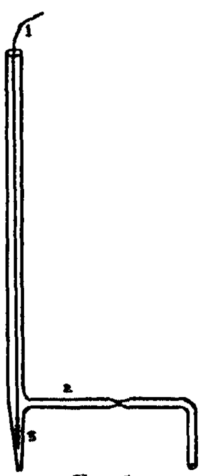

FIG. 1

"1" is a platinum wire 29 gauge, connected with the potentiometer system and extending down through the electrode vessel into the capillary "3." At the lower end it is coated with quinhydrone according to the Pierce technique. "2" is a side arm containing a firm saturated KCl agar bridge, extending into saturated KCl and through this connected with the saturated calomel electrode. The constriction lends immovability to the gel. "3" is a capillary 12 mm long, 0.25 mm at the lower end and increasing to 2 mm at the upper end where it joins with "2." Generally the capillarity of "3" is sufficient to bring the liquid in contact with the bridge in "2," if not, gentle suction may be applied at the top of the electrode vessel by means of a syringe prior to the insertion of the platinum wire.

	Calculated pH	Determined pH
	7.01	6.93
	6.81	6.79
	6.91	6.89
	7.36	7.42
M/20 potassium biphthalate, 25° C.	3.97	3.98

The tumor fluid of Walker rat sarcoma No. 319[7] showed a pH lying between 7.50 and 7.70.

JOHN C. KRANTZ, JR.
C. JELLEFF CARR
RUTH MUSSER

SCHOOL OF MEDICINE,
UNIVERSITY OF MARYLAND

A SIMPLE CARBORUNDUM PENCIL

ONE of the problems which so frequently confronts the microtechnician, be he botanist, zoologist or bacteriologist, when staining, is to determine on which side of the slide the sections (or bacteria) are. In attempting to insure getting the correct answer to his question he may use a glass or pottery pencil, he may make a scratch on the slide with a small piece of carborundum, he may use the more expensive slides with one end "frosted" or he may merely trust to luck. However, none of these methods is entirely satisfactory when it is necessary to put considerable data upon the slide, such as the cytologist or cyto-geneticist finds necessary in his work.

For myself, I have, while being concerned with a cyto-genetical study, solved this problem of keeping the sections properly orientated by means of a very simple, but practical, tool which was easily constructed.

A small, all-wood penholder was used and the inside of the pen-end was scooped out to a depth of 2–2.5 cm. This cavity was filled with a thick paste of plaster of Paris and a piece of carborundum 15 × 3 mm imbedded in the paste so as to leave about 5 mm protruding beyond the end of the penholder. After the plaster of Paris has formed a rigid matrix one is able to make fine lines, small numbers or letters on his slides.

This device has proven far more satisfactory than any of those methods previously used. Likewise, such a tool is certainly good insurance against loss of valuable sections and data.

ROY MILTON CHATTERS
UNIVERSTY OF MICHIGAN

[7] W. Schopper, *Arch. f. exper. Zellforsch.*, 14: 14, 1933.

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SPECIAL ISSUE CONTAINING REPORTS OF THE SECOND ATLANTIC CITY MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES

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THE ATLANTIC CITY MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES

Edited by Dr. HENRY B. WARD
PERMANENT SECRETARY

GENERAL FEATURES

THE ninety-ninth meeting in the series of the association was held in Atlantic City from December 28, 1936, to January 2, 1937. Once before this city had been host to the association, namely, in 1932 for the ninety-first meeting. In a way conditions in Atlantic City differ markedly from those under which meetings are usually held. The community can boast of no university, no research laboratories, no great museum. But it does offer unrivaled opportunities for comfort and convenience in holding a great assemblage of sections and societies, desiring at the same hours some fifty to sixty separate meeting halls adequate in size and convenient in place and equipment for the sessions of these diverse groups. It has also another advantage in that it can furnish these facilities within a distance of only a little more than a mile, eliminating thus the time and expense involved in reaching meeting places often widely separated in a great city. The Municipal Auditorium, admirably planned for convention purposes, and the big hotels close by with capacious and attractive audience rooms housed well all the lectures, conferences, demonstrations and other gatherings held in Atlantic City. One could go in short order from one session to another or to make contact with members in some other society headquarters without spending much time in transit. It is worth while recording the fact that many members and officers, especially secretaries, expressed themselves at the close of the week as highly appreciative of the satisfactory arrangements made for the meeting.

The attendance at Atlantic City was large; room assignments provided on the basis of usual audiences were taxed to the utmost to provide for the numbers present and records of sections and societies indicated a total attendance well over four thousand. Official

registrations amounted to 2,375. Of these New York contributed 561, Pennsylvania 326, New Jersey 193, Massachusetts 170, District of Columbia 154, Maryland 137, Connecticut 101, Illinois 90, Ohio 84, Virginia 63, North Carolina 46, Michigan 39, Minnesota 31, Maine 29, Iowa 24, California, Missouri and Wisconsin 23 each, New Hampshire 22, Rhode Island 20, Indiana 19, Georgia 18, West Virginia 16, Texas 12, Delaware 11, Louisiana, Tennessee and Vermont 10 each, Kentucky 9, Florida and South Carolina 8 each, Colorado 7, Kansas 6, Alabama, Arizona, Atlantic City, Utah and Wyoming 4 each, Oregon 3, Arkansas, Idaho, Mississippi, Montana, Nebraska and Oklahoma 2 each. Outside the continental United States Canada furnished 23 registrants, Puerto Rico 4, China, Hawaii and India 2 each, and the Canal Zone, England, Ireland and the U. S. S. R. one each.

GENERAL SESSIONS

The opening general session on Monday evening was held in the Ball Room of the Municipal Auditorium. In the chair was the president of the association, Dr. Edwin Grant Conklin, professor emeritus of Princeton University. On the stage sat also the other officers of the association and presidents of 16 prominent affiliated societies. The audience which greeted them filled the room to capacity. After a brief felicitous address of welcome, Dr. Conklin introduced the retiring president of the association, Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, who addressed the assemblage on the subject, "The Electron: Its Intellectual and Social Significance." This address has been printed in full in SCIENCE for January 8. Following the address the association adjourned to Haddon Hall, where a reception in the spacious lounge was tendered to officers and members by the Atlantic City Convention Bureau. The attendance was large and the occasion was most enjoyable.

Tuesday evening the general session was devoted to the fifteenth annual lecture of Sigma Xi. Dr. Henry G. Knight, chief of the U. S. Bureau of Chemistry and Soils, was the speaker of the occasion; his subject, "Selenium and Its Relations to Soil, Plants, Animals and Public Health."

On Wednesday evening was given the second annual lecture sponsored by the United Chapters of Phi Beta Kappa. The speaker of the evening was Dr. James R. Angell, president of Yale University, and his subject, "The Scholar and the Scientist." Dr. Angell voiced an earnest plea for broader training. Recognizing that for real genius all rules go by the board, he pointed out the urgent need of a cultural background for others who seek to make their work effective. He deplored current sloppy intellectual habits and the loss of ability to express oneself effectively to the world at large. As intellectual life insurance the scientific worker should plan to devote a definite measure of time to those masterful works which will develop breadth and culture.

Five special afternoon lectures were given on successive days at 4:30. These were the following: "The Optics of the Surface of the Sea," by Dr. E. O. Hulburt, of the Naval Research Laboratory of Washington; "Science and the American Press," by David Dietz, science editor of Scripps-Howard Newspapers; "Response of Plants to Hormone-like Growth Substances," by Dr. P. W. Zimmerman, of the Boyce Thompson Institute for Plant Research; "The Social Significance of Cancer," by Dr. C. C. Little, of the Roscoe B. Jackson Memorial Laboratory, and "Changes and Modifications in the Conception of Carcinoma," by Dr. Walter Schiller, of the University of Vienna, Austria. These lectures attracted good audiences and were highly appreciated.

FRIDAY AND SATURDAY PROGRAM

The advance plans made by the Executive Committee for special programs of general interest on Friday and Saturday were carried out with marked success. Friday morning was devoted to meetings of committees and conferences, the most important of which was the Secretaries' Conference. This was well attended and the lively discussion of general association problems prolonged even into the lunch hour. The demonstration symposium on "The Moving Picture in the Service of Science," which was given on Friday afternoon in two large audience rooms at Haddon Hall, presented a wide variety of scientific studies illustrated by unique films made in connection with the work and showing its character and results in vivid fashion. Professor E. M. K. Geiling, of the University of Chicago, demonstrated realistically under the title of "Whaling for Science" work done by L. L. Robbins and himself in pursuit of whales and in securing specimens of the pituitary gland on which he has made important studies. In a color film entitled "A Health Educator with a Ciné-Kodak in the Orient" Dr. C. E. Turner, of the Massachusetts Institute of Technology, reviewed his trip as chairman of the Health Section of the World Federation of Education Associations. Motion pictures in natural color, chiefly from India, Bali and Japan, depicted the scenic marvels of regions visited and through modes of life illustrated the problems of population, sanitation and also the dispersion of disease from the areas studied. Dr. Harold E. Edgerton, of the Massachusetts Institute of Technology, showed a series of "High Speed Motion Pictures of the Flight of Birds and of Bullets." These pictures demonstrated vividly the use of the highly refined technique in making accurate measurements for scientific and engineering

research far beyond limits attained under previous methods.

In the other room Dr. William Beebe's reels were shown with their effective illustration of the life history of stages in the development of the eel and the activities of other deep sea fish. Perry Burgess, president of the Leonard Wood Memorial, in the sound movie entitled "Miracles in the South Sea" furnished a dramatic demonstration of the bright side of life at the great leper colony at Culion, on the shore of the China Sea, and the remarkable results achieved there by the modern methods employed in the treatment of leprosy.

Later on Friday afternoon Dr. Walter Schiller, of the University of Vienna, Austria, gave the final address in the symposium on cancer. His subject was "Changes and Modifications in the Conception of Carcinoma." A large audience listened with deep interest to the address.

The final event of the Atlantic City program was the showing on Friday evening of "The Human Adventure." This eight-reel talking picture was produced under the personal supervision of the late Professor James Henry Breasted and was planned to show the rise of man from savagery to civilization. The sound record in the second reel is in the voice of Dr. Breasted himself, and the entire film was produced at the Oriental Institute of the University of Chicago. The story was written and, except for the second reel, told by Mr. Charles Breasted. A large audience, in which were many former colleagues and old friends of Dr. Breasted, saw the film, which was exhibited through the courtesy of Wendell G. Shields, of New York City.

Early on Saturday morning members and guests of the association took the train for Philadelphia and assembled in the hall of the American Philosophical Society. The meeting was called to order by Roland S. Morris, who, as president of the society, extended a cordial welcome to the guests and then introduced Dr. Conklin, president of the association, to take charge of the program which he had arranged. The first paper, on "Some Biochemical Investigations on Crystalline Tobacco-Mosaic Virus Proteins," by Dr. W. M. Stanley, of the Rockefeller Institute, presented further work on the theme for which the author had been given the Association Prize at Atlantic City. Other papers on the program were the following: "The Ultra-centrifugal Concentration of Viruses and Other Biologically Active Proteins," by Dr. Ralph W. G. Wyckoff, of the Rockefeller Institute; "Labile Bacterial Antigens and Methods of Their Preparation and Preservation," by Dr. Stuart Mudd, of the University of Pennsylvania School of Medicine; "The Rôle of a Filterable Virus in Upper Respiratory Infection," by Dr. Yale Kneeland, of Columbia University; and "The Transformation of the Virus of Rabbit Fibroma (Shope) into that of Infectious Myxomatosis (Sanarelli)," by Dr. George Packer Berry, of the University of Rochester. After the luncheon tendered by the American Philosophical Society, visitors were taken to the Academy of Natural Sciences and to the Franklin Institute, where tea was served. This marked the close of the Philadelphia excursion, which was accounted a new and most agreeable feature of the 1936 meeting.

GEORGE DAVID BIRKHOFF—PRESIDENT-ELECT OF THE ASSOCIATION

(*By Lyman T. Briggs*)

AGAIN the American Association for the Advancement of Science has chosen a distinguished mathematician as its new president. But physicists as well as mathematicians may feel honored by his selection, because many of Professor Birkhoff's contributions, such as his development of the differential equations of dynamics and electricity, his treatise on relativity and his conceptual theories of matter, have enriched the field of mathematical physics.

George David Birkhoff was born of Dutch ancestry in Overisel, Michigan, on March 21, 1884. Following preparatory studies at Lewis Institute and the University of Chicago, he entered Harvard in 1903 and received his A.B. degree two years later, when he was twenty-one. His ability as a mathematician was early in evidence, for in his junior year he read an important paper before the American Mathematical Society, which was later published in its *Transactions*. Returning to the University of Chicago for post-graduate study under the stimulating guidance of Professor Moore, Birkhoff received his doctorate in 1907.

After teaching two years at the University of Wisconsin, Birkhoff joined the mathematical faculty at Princeton and became the editor of the *Annals of Mathematics*. In 1912 he was invited to return to Harvard, where he has remained and now holds the Perkins research professorship and is also dean of the Faculty of Arts and Sciences. As evidence of his catholicity of interests, which this latter position implies, his latest book, "Aesthetic Measure," reflects the approach of an orderly mind into the domain of the fine arts.

Birkhoff was among the first in America to take up the study of relativity, and the title of his book—"The Origin, Nature and Influence of Relativity"—shows the breadth of view with which he approached the subject. While he was one of the leading exponents of relativity he nevertheless subjected the new theory to rigid entrance requirements: "The usefulness of an abstraction is relative to its inherent simplicity of structure and its agreement with the facts.

For example, the usefulness of the theory of relativity depends on the circumstance that it possesses the same inherent simplicity as the classical theory, while it explains more facts than that theory did."

Birkhoff was elected to membership in the National Academy of Sciences at the age of thirty-four. Only a few men, such as Newcomb, Michelson, Hale and Theodore Richards, have won this distinction at such an early age. He is a past president of the American Mathematical Society, which awarded him the Bôcher prize in 1923 for his researches in dynamics. He has been elected to honorary membership in the French Academy of Sciences, the Göttingen Scientific Society, the Royal Danish Society of Sciences and Letters, the Royal Academy of Sciences (*dei Lincei*) and the Academy of Sciences at Bologna. The new Pontifical Academy of Science not only included him in its limited list of foreign fellows, but awarded to him its prize for his investigations of systems of differential equations. He has received from Venice the Quirini-Stampalia prize. He is an officer of the French Legion of Honor. Brown, Wisconsin, Harvard and the University of Paris have given him honorary degrees.

Dean Birkhoff's election as president is not the first honor accorded to him by the American Association for the Advancement of Science. In 1926 he was awarded the Association Prize of one thousand dollars for an outstanding paper in the program of the Philadelphia meeting. Schrödinger had announced only a few months previously his discovery of a fundamental wave equation. Birkhoff showed how this equation could be arrived at in an entirely different way, by means of a conceptual theory of matter and electricity. At the Atlantic City meeting he presented the results of his more recent studies in this field, which provide the groundwork for a conceptual theory of atomic structure.

THE ASSOCIATION PRIZE AWARD

The fourteenth annual award of the Association Prize for a noteworthy contribution to the program of the meeting was made at Atlantic City. The committee on award voted unanimously to give the $1,000 prize to Dr. W. M. Stanley for the paper entitled "Crystalline Tobacco-Mosaic Virus Protein." This paper was read before a joint meeting of the Section on Botanical Sciences and the various botanical societies meeting in Atlantic City, on Tuesday afternoon, December 29. The membership of the Atlantic City committee on award consisted of C. C. Little, *chairman*, Jackson Memorial Laboratory; E. C. Faust, Tulane University School of Medicine; E. R. Hedrick, University of California at Los Angeles; H. T. Stetson, Massachusetts Institute of Technology, and David L. Webster, Stanford University.

THE PRIZE PAPER AND ITS AUTHOR

(*By Vincent du Vigneaud*)

The committee awarded the prize at the Atlantic City meeting to Dr. Wendell M. Stanley, biochemist of the Rockefeller Institute for Medical Research in Princeton, N. J., for his paper entitled "Chemical Studies on the Virus of Tobacco Mosaic."

The isolation of this typical virus in crystalline form and its recognition as a high molecular weight protein are without question a fundamental discovery, the far-reaching significance of which can probably only be partially grasped at the present time. Infection by the virus may be regarded as due to the introduction of a few molecules of the virus protein into a susceptible host. These few molecules apparently have the ability to so disarrange the normal metabolic reactions as to cause the cell to manufacture more of the virus protein. The work has also indicated that in the production of the virus protein by the host new strains may arise, through perhaps the chance production of one or more molecules of a slightly different structure, thus giving mutation of the virus. As Stanley has pointed out, the virus can not be regarded as simply an autocatalytic agent but must be regarded as a new type of super-catalyst, being able to cause the cell to produce more molecules in its own likeness.

The tobacco-mosaic virus was selected four years ago by Dr. Stanley for his studies, since the tobacco mosaic was one of the longest known of the viruses, was regarded as a typical virus, and the source of material was plentiful. His early work indicated that the compound was a protein, and his researches were therefore directed along this line of approach. The work led to the isolation from mosaic-diseased plants of a crystalline protein, possessing the properties of the virus. It turned out to be a protein of surprisingly high molecular weight, namely, seventeen million. The chemical studies which were particularly reported upon at the Christmas meetings have brought forth almost incontrovertible evidence that this protein is truly the tobacco-mosaic virus. The virus activity, chemical composition and optical rotation of the protein from various sources were the same and furthermore remained constant during ten recrystallizations of the protein. Other criteria have also failed entirely to indicate a separate identity for the virus activity and this crystalline protein. The studies have also brought out the fact that this high molecular weight protein does not exist in normal plants. The same protein or closely related protein has been isolated from mosaic-diseased tomatoes, spinach and phlox plants. The work has also led to the isolation of two crystalline proteins from plants infected with a masked and with a yellow strain of tobacco-mosaic virus, respectively. These proteins, although they are

very much alike and resemble the tobacco-mosaic virus protein, possess certain small chemical and physical differences.

Another observation of far-reaching importance made by Dr. Stanley was in the immunological work with the active and inactivated virus. Methods have been evolved for inactivating the virus so that the inactive virus gives about the same immunological action as that given by the untreated virus. Apparently the virus has been so modified as to interfere with its catalytic action, but yet is sufficiently close in structure to the original protein so that it can give immunological reaction. This observation may be useful in the studies of other virus diseases in inducing immunity with inactive virus.

As Dr. Stanley has stated, "It is now possible to list protein molecules along with living organisms such as bacteria, fungi and protozoa as infectious disease producing agents." Dr. Stanley well recognized, however, that all the disease-producing agents, now classified as viruses, may not all turn out to be high molecular weight proteins but that some might prove to be truly living bodies and that at this early stage of our knowledge different types of filterable disease-transmitting agents may have been classified under the one heading of viruses.

Dr. Stanley was born in Ridgeville, Indiana, on August 16, 1904, and graduated with the degree of bachelor of science from Earlham College in 1926. In 1927 he received his master of science degree from the University of Illinois, where he received his degree of doctor of philosophy two years later under Professor Roger Adams. Dr. Stanley then spent one year as private research assistant to Professor Adams and then the following year became an International Research Council fellow, studying in Munich, Germany, in the laboratory of Professor Wieland. On his return in 1931 he joined the staff of the Rockefeller Institute at New York, working with Dr. W. J. V. Osterhout and then later transferred to the institute's branch at Princeton.

Dr. Stanley's previous work had been concerned with the synthesis of possible anti-leprosy compounds, with the stereochemistry of diphenyl compounds, with the isolation and purification of the sterols of yeast and with synthetic models of plant processes.

IMPORTANT COUNCIL ACTIONS

Several aspects of the general problem of association relations in this period of social change were thoroughly discussed by the council and steps taken to extend the range of association activities, to determine the part to be played in some public problems and to establish relations with similar organizations in other countries. On recommendation of the council, the general session, held on Monday evening, December 28, adopted an amendment to the constitution changing the name of the Section on Manufactures and Commerce (P), as listed in the constitution but never organized, to Section on Industrial Sciences (P). The council approved the policy of strengthening the ties between the association and the British Association for the Advancement of Science and organizations of similar character in other countries.

The problem of maintaining intellectual freedom and at the same time assuming social responsibility was brought before the council by President Conklin. After prolonged discussion and reference to the executive committee the latter reported to the council the fact that a regularly appointed committee of three, consisting of Dr. Isaiah Bowman, chairman, Dr. Cattell and Dr. Ward, had been cooperating with other scientific and educational groups on the problems of intellectual freedom and social responsibility. After much discussion the council voted to increase the membership of this committee to five, by adding the names of the president and retiring president to the committee, that the committee act as a permanent standing committee of the association, and that it be directed to persist in its efforts to cooperate with other bodies and to report its activities to the council and to the general assembly each year.

President Conklin announced that Newcomb Cleveland has given the association this year $2,000 for the use of the committee on grants. The council adopted a unanimous vote of thanks and appreciation for this most useful gift.

The council voted to elect the following persons as emeritus life members under the Jane M. Smith Fund: F. P. Dunnington, Professor John Eric Welin, Richard N. Brackett and Dr. Frank Leverett.

The following persons were elected emeritus annual members under the Luella A. Owen Fund: Dr. Beverly T. Galloway, Professor Clarence P. Gillette and Dr. Frederick J. Wulling.

Dr. J. McKeen Cattell, chairman of the executive committee, presented a resolution expressing the appreciation of the association for the long and faithful services of the permanent secretary and a desire on his part to be relieved of the duties of the position. The council adopted unanimously the resolution as follows:

WHEREAS, Dr. Henry B. Ward has served on the council and executive committee of the American Association for the Advancement of Science with loyalty and devotion for many years, and

WHEREAS, Dr. Ward is now completing a term of office as permanent secretary, during which time he has further served the association with loyalty to the interests of the organization, and

WHEREAS, Dr. Ward indicated some time ago that he

would desire in the near future to be relieved of the duties of the office of permanent secretary,

Be it therefore resolved, that the American Association for the Advancement of Science express its deep appreciation to Dr. Ward for his long and faithful services and commend him for his sincere devotion to the office of the permanent secretary in advancing the cause of science.

Officers of the association were elected as given in the list published in SCIENCE for January 8, pages 40 and 41.

On recommendation of the executive committee the council appointed Dr. Henry B. Ward acting permanent secretary until May 1, 1937, or until Dr. Moulton could assume the duties of the office.

An invitation to visit the Stanley S. Holmes Village, an Atlantic City slum clearance project of the Public Works Administration, was extended to the association and accepted by the council, which also recorded the thanks of the association and associated societies for the courtesy extended.

The American Science Teachers' Association was on motion accepted as an associated society.

In appreciation of the work done by the local authorities and courtesies extended, the following minute was ordered entered on the minutes of the meeting and communicated to the parties concerned:

The record of the second Atlantic City meeting of the American Association for the Advancement of Science demonstrates clearly the success of the efforts made by the local authorities to provide for the comfort and convenience of a large and varied series of scientific sessions. The fine Municipal Auditorium and the great hotels brought together within easy distance of each other meetings of sixteen sections and more than forty associated societies and conferences in rooms at once commodious and well fitted for the individual purposes involved. The officers and council of the American Association for the Advancement of Science wish to record their appreciation of the work of the Atlantic City Convention Bureau, especially its director, Mr. A. H. Skean, and of the management of the hotels and their efficient officials for the many courtesies extended and the constant care that contributed in so many ways to the success of the meetings.

Before adjournment the following resolution was adopted concerning the summer program and the cooperation of the Ecological Society of America:

The American Association for the Advancement of Science appreciates the excellent and effective efforts of the Ecological Society of America to protect exemplary natural areas in this country from ill-advised encroachment, to the end that remarkable and instructive ecological and scenic features may be preserved in perpetuity. The association is specially appreciative of the fine cooperative work of the society in arranging and conducting a symposium for the general program at Minneapolis and also at Rochester, and it invites the society to take similar special part at summer meetings in the future, by arranging and conducting a symposium of invited addresses on some timely and locally appropriate subject, which may be announced under joint auspices of the association and the society.

FINANCIAL REPORTS

Audited financial reports of the permanent secretary and the treasurer for the fiscal year 1936, together with proposed budgets for 1937, were presented and approved, and a digest of the same ordered printed. This follows:

OFFICE OF THE TREASURER
BALANCE SHEET
September 30, 1936

Assets			
Investments			
Securities			$249,686.36
Cash			
Income account		$ 1,472.62	
Reserve for current needs		14,051.81	15,524.43
			$265,210.79
Liabilities			
Endowment and other Funds	*Research*	*General*	
W. Hudson Stephens		$ 4,381.21	
Richard T. Colburn	$ 87,186.45		
Michael P. Rich		10,000.00	
Friends of the Association		3,559.00	
Hector E. Maiben		31,448.17	
Sustaining Membership Fees:			
Living		1,000.00	
Deceased	6,000.00		
Life Membership Fees:			
Living		40,050.00	
Deceased	15,250.00		
	$108,436.45	**$90,438.38**	**$198,874.83**
Jane M. Smith:			
Donation		$ 5,000.00	
Credited fees of Deceased Emeritus Life Members		3,300.00	$ 8,300.00
Luella A. Owen			500.00
Reserve Fund			32,306.16
Emergency Reserve Fund			11,177.99
Prize Fund			4,000.00
Grants:			
Committee (L. M. Dickerson)		$ 50.00	
Affiliated state academies		1,300.00	1,350.00
Accumulated Income Unappropriated			
Endowment and other funds:			
Research	$ 4,407.91		
General	3,787.13	$ 8,195.04	
Jane M. Smith		471.88	
Luella A. Owen		34.89	8,701.81
			$265,210.79

CASH STATEMENT
October 1, 1935 to September 30, 1936
Receipts

Balance from last report (September 30, 1935)			$ 17,191.65
Prize Fund		$ 1,000.00	
Life Membership		700.00	
Revertment from Grants		39.84	
Bonds redeemed:			
5,000 Cinn. U. Term 5s, 2020	$ 5,375.00		

1,000 Am. Tel. and Tel. Co. 5s, 1946		1,050.00		
5,000 Brooklyn Edison Co. 5s, 1952		5,200.00		
5,000 N. Y. Edison Co. 5s, 1951		5,198.00		
10,000 Consl. Gas of N. Y. 5s, 1957		10,298.50		
8,000 Park and Tilford Co. 6s, 1936		8,000.00	35,121.50	
Refund from Collection charges			2.85	
Income:				
Endowment:				
Research..	$4,407.91			
General ..	3,787.13	$ 8,195.04		
Reserve Fund		1,206.17		
Special Emergency Reserve		641.05		
Special Funds:				
Jane M. Smith ..	$ 341.68			
Luella A. Owen ..	20.83	362.51	10,404.77	47.268.96
				$ 64,460.61

Disbursements

Investments:		
15,000 Consl. Edison 3½s, 1956 ..	$14,925.00	
5,000 Pac. Tel. and Tel. ref. 3½s, 1966	5,075.00	
10,000 N. Y. Edison 3½s, 1966	10,200.00	
5,000 Ind. Water Co. 3½s, 1966 ..	5,037.50	35,237.50
Grants for Research		3,000.00
Academy grants, 1935 and 1936		2,500.00
Prize Fund, P. W. Zimmerman and A. E. Hitchcock		1,000.00
Jane M. Smith Fund, three emeritus life memberships		300.00
Luella A. Owen Fund, three emeritus annual memberships		15.00
Fifty-year members, journal subscriptions		24.50
Life membership subscriptions for SCIENCE		1,506.00
Hector E. Maiben lecture—Charles Camsell		137.63
From Special Emergency Reserve to Permanent Secretary		5,000.00
Purchased interest on bonds		152.71
Safe deposit box and collection charges		62.84
		$ 48,936.18
Cash on hand (September 30, 1936)		15,524.43
		$ 64,460.61

OFFICE OF THE PERMANENT SECRETARY
RECEIPTS AND DISBURSEMENTS FOR THE FISCAL YEAR 1935–1936
October 1, 1935, to September 30, 1936

Receipts

To balance from last account:		
Cash in banks	$ 1,230.18	
Reserve in Treasurer's hands	15,536.94	$ 16,767.12
Membership dues and fees:		
Annual dues previous to 1935	140.00	
Annual dues for 1935	1,066.00	
Annual dues for 1936	81,788.42	
Advance payments for dues, etc. ..	885.50	
Entrance fees	170.00	
Life-membership fees	700.00	84,749.92
Other general receipts:		
Life-membership journal subscriptions (from Treasurer)	1,521.00	
Interest on bank accounts, etc. ...	745.91	
Sales of Summarized Proceedings .	57.50	
Sales of "Nationalism"	5.00	
Sales of booklists	2.50	
Overpayments	54.25	
Miscellaneous receipts	18.00	2,404.16
Special journal subscriptions:		
SCIENCE and *Scientific Monthly* ...	2,346.00	
Science News Letter	321.00	2,667.00
Saint Louis Meeting:		
Registration fees	2,188.00	
Exhibition—Receipts from exhibitors	4,749.00	6,937.00
Rochester Meeting:		
Registration fees		514.00
Atlantic City Meeting:		
Exhibition—Initial payments from exhibitors		1,050.00
		$115,089.20

Disbursements

Subscriptions to official journals, including foreign postage				$ 51,775.50
Allowances to Divisions and Academies:				
Divisions			$ 2,275.00	
Affiliated academies			410.50	2,685.50
Expenses of Washington Office:				
Salaries			17,163.78	
Office and addressograph supplies .			365.87	
Printing and stationery			1,636.19	
Telephone and telegraph			190.79	
Postage			1,422.57	
Exchange			37.32	
Express, freight, and drayage			20.59	
Office equipment			215.10	
Binding SCIENCE			317.95	
Miscellaneous expenses			538.43	21,908.59
Expenses, General Secretary's Office				577.62
Expenses, Treasurer's Office				200.00
Circularization, inviting new members				6,251.68
Miscellaneous expenditures:				
Life-membership fees to Treasurer.			700.00	
Refunds of overpayments			54.25	
Minneapolis Meeting:				
Travel expenses, Executive Committee	$ 125.70			
Travel expenses, Section Secretaries	131.80	257.50		
Saint Louis Meeting:				
General expenses	2,745.54			
Travel expenses, Executive Committee	787.52			
Travel expenses, Section Secretaries	1,377.87			
Miscellaneous section expenses	1,042.45			
Exhibition	3,086.13			
Press Service	648.90	9,688.41		
Rochester Meeting				
General expenses	1,380.10			
Travel expenses, Executive Committee	601.38			
Travel expenses, Section Secretaries	73.43			
Miscellaneous section expense	153.79			
Press Service	268.11	2,566.81		
Atlantic City Meeting:				
General expenses	93.12			
Exhibition	1,640.77	1,733.89		
Denver Meeting:				
General expenses		103.83	15,104.69	
Miscellaneous travel expenses				843.51
Expenses of Committee on Place of Science in Education				361.18
Expenses of Committee on Popular Science Reading Lists				1,442.76
Special journal subscriptions:				
SCIENCE and *Scientific Monthly* ..			$ 2,364.00	
Science News Letter			327.00	$ 2,691.00
				$103,842.03
By new cash balances:				
Cash in banks			68.73	
Reserve in Treasurer's hands			11,178.44	11,247.17
				$115,089.20

STATUS OF FUNDS

	September 30, 1936	September 30, 1935
Publication Fund	$ 1,695.34	$ 637.84
Emergency Fund	5,000.00	5,000.00
Unallocated Funds	3,436.22	8,212.34

Special fund for Committee on the Place of Science in Education ..	912.28	1,274.46
Special fund for Committee on Popular Science Reading Lists ..	203.33	1,643.59
	$11,247.17	$16,767.12

The accounts of the treasurer and permanent secretary were audited under the direction of Dr. W. J. Humphreys, official auditor of the association. Complete financial reports and accompanying papers are on file and copies are available if desired.

MEMBERSHIP REPORT

The following summary is taken from the membership report as submitted to the council:

	September 30, 1935	September 30, 1936
Sustaining members	1	1
Life memberships	506	496
Annual members, paid-up	15,966	16,511
Total	16,473	17,008
Arrearages, one year's dues	803	706
Arrearages, two years' dues	661	528
Total	17,937	18,242

A slight increase in paid-up membership will be noted: 93.2 per cent. for 1936 against 91.8 per cent. for 1935. During the year 1,477 names were added to the rolls and 36 were reinstated. On January 15, 1937, the total membership enrolment was 18,381.

THE TWO CONFERENCES

The Academy Conference was called to order at 4 P. M. on Monday, December 28, 1936, by Chairman W. H. Alexander, of the Ohio Academy. Howard E. Enders, of the Indiana Academy, presented a report dealing with the types of research projects to which the research grants have been applied. These projects include purchase of needed research apparatus, expenses of field work in collecting data, employment of research assistance, tabulation of data and indeed they include a wide range of activities classified under the name of research. Discussion developed the conclusion that it is not now desirable to have any rules regarding the types of research to which the various academies devote these funds. It was reported that several academies have been able to supplement the research grants from the association through funds secured within the states concerned.

The methods used by different academies in allocating the research grants was discussed. It was decided that this should be a topic for careful consideration at the next annual meeting. Then followed the dinner given by the association as host to the academy delegates. Throughout the dinner there was continuous discussion of academy interests, this discussion being engaged in by the delegates and members of the executive committee of the association. E. C. Faust, of the New Orleans Academy, was elected chairman for next year and S. W. Bilsing, of the Texas Academy, was reelected as secretary.

The Secretaries' Conference was held on Friday morning with General Secretary Otis W. Caldwell in the chair. Vigorous discussion was devoted to consideration of detailed problems in arranging and conducting the meetings of sections and affiliated societies and in establishing closer and more effective relations between the association and its associated organizations. The function of this conference is advisory rather than legislative, and its general conclusions are made the subject of a report by the secretary of the conference, M. H. Ingraham, to the executive committee and council. Its work has been most helpful in perfecting the organization of the association and the work of its meetings. The session was terminated by a complimentary luncheon.

THE ANNUAL SCIENCE EXHIBITION

(*By F. C. Brown*)

The Annual Science Exhibition in Atlantic City was distinctly the best yet held. In the first place the exhibits were more numerous and more varied than heretofore. They were more harmonious and better decorated. The facilities and the management of the Auditorium, together with its short distance from all the meeting places, played an important rôle in the success of the exhibition.

The astronomy exhibition, under the chairmanship of Dr. Harlan T. Stetson, was distinctive. The generous cooperation of the American Museum of Natural History and the personal attention of Dr. Barton added materially. The cooperation of others was noteworthy.

The meteorological exhibition, under the chairmanship of S. P. Fergusson, had the cooperation of all the leading research institutions and commercial firms in this field. According to Dr. Charles F. Brooks, director of the Blue Hill Observatory, it was the most extensive exhibition held since 1889. It is gratifying that some firms, such as the Taylor Instrument Companies, Inc.; Julien P. Friez and Sons, Inc., and R. Fuess, Inc., not only assisted in the general set-up but also had distinctive booth displays.

Aside from the colorful atmosphere of the exhibition generally, the most noteworthy advance was in the increased demonstrations by commercial institutions, such as the Aetna Casualty and Surety Company, the Ajax Electrothermic Corporation, the Hanovia Chemical and Manufacturing Company, Fred S. Carver, the Radio Corporation of America, Erpi Picture Consultants and others.

PRESS SERVICE

(*Report by Austin H. Clark*)

Out of about 1,500 papers listed in the program this year only 257 were received by the Press Service in advance of the meeting. An additional 79, including many of much importance, arrived too late for use.

Manuscripts of all papers and addresses given should be sent to the Press Service at least two weeks in advance of the meetings. This is essential if they are to receive adequate preliminary study by the press representatives. It is also essential if they are to be mimeographed and distributed.

From the press view-point it is highly desirable that the important addresses be more or less evenly distributed between morning and afternoon and evening. If they are all in the afternoon or evening the afternoon papers are at a great disadvantage—the morning papers get all the good things. Why not begin the day with good breakfast addresses as well as end it with good dinner addresses?

Let us bear these things in mind and endeavor to make the Indianapolis meeting an outstanding success from the press view-point, as it is sure to be from the scientific view-point. We can do it. And I am enough of an optimist to feel sure we will.

RADIO PROGRAMS AT THE MEETING

The following broadcasts were made during the meeting of the association from Atlantic City and Philadelphia. They were carried out through the courtesy of the companies indicated. Other data appear in the following summary:

National Broadcasting Company (WEAF Red Network)

December 28, 1936, Monday, 7:30 to 7:45 P. M.
E. G. Conklin, Princeton University, president of the American Association for the Advancement of Science.
Topic: "Science and Human Welfare."

December 29, 1936, Tuesday, 6:00 to 6:15 P. M.
A. H. Compton, University of Chicago, sponsor, and R. C. Buffum.
Topic: "Science in the News."

December 30, 1936, Wednesday, 5:00 to 5:15 P. M.
Wm. Crocker and Otis W. Caldwell, Boyce Thompson Institute.
Topic: "How do Plant Hormones Act?"

December 31, 1936, Thursday, 6:00 to 6:15 P. M.
Howard Blakeslee, Associated Press; David Dietz, Scripps-Howard Newspapers; John O'Neill, *New York Herald-Tribune*, and Otis W. Caldwell, general secretary, the American Association for the Advancement of Science.
Topic: "Science and the Press."

January 2, 1937, Saturday, 6:00 to 6:15 P. M., Philadelphia. (KYW, NBC Red Network.)
Otis W. Caldwell, Boyce Thompson Institute; Watson Davis, Science Service, and Franklin Dunham, National Broadcasting Company.
Topic: "The Week of Science Meetings."

Columbia Broadcasting Company (Atlantic City Station WPG)

December 28, 1936, Monday, 2:30 to 2:45 P. M.
Howard E. Enders, Purdue University; Otis W. Caldwell, Boyce Thompson Institute; C. L. Mellinger, Science Department, High School, Atlantic City; Evelyn M. Fansler, Atlantic City High School Science Club, and Alton Meister, New York City High School Science Clubs.
Topic: "The Science Youth Movement."

December 29, 1936, Tuesday, 2:30 to 2:45 P. M.
Watson Davis, Science Service.
Topic: "The Year in Science."

December 30, 1936, Wednesday, 2:30 to 2:45 P. M.
F. B. Knight, University of Iowa.
Topic: "Is Education a Science?"

The general program made a book of 200 pages; copy was prepared and printing supervised by Sam Woodley, executive assistant of the association. In the program was included the record of sixteen sections and more than forty associated societies with numerous extra lectures, conferences and other meetings making in all over 180 separate sessions. The book lists 1,450 papers in different programs. This brief statement gives abundant evidence of the complexity of the plans to be worked out by the officers of the association and of societies cooperating in the meeting. As far as the surplus of copies of the printed program on hand will suffice, members may secure one on application by mail to the office of the permanent secretary.

SCIENTIFIC SESSIONS

SECTION ON MATHEMATICS (A)

(*Report from E. R. Hedrick*)

The meetings of the Section on Mathematics were held on Monday and Tuesday afternoons and in conjunction with the Section on Astronomy on Thursday afternoon.

On Monday afternoon W. J. Trjitzinsky read a paper on "Analytic Theory of Non-Linear Singular Differential Equations," Marston Morse a paper on "Homotopic Extremals," C. N. Moore a paper "On the Regularity of Methods of Summation of Multiple Series," and G. C. Evans a paper on "Equilibrium Problems for Potentials of Positive and Negative Mass."

On Tuesday afternoon T. H. Hildebrandt delivered his retiring address as vice-president of the association and chairman of the Section on Mathematics, on "Recent Developments in the Theory of Integration." After a recess, J. A. Shohat read a paper on "Appli-

cation of Laguerre Polynomials," M. H. Ingraham a paper on "Certain Aspects of the Mathematical Theory of Genetics," and A. L. Whiteman a paper "On a Set of Postulates for Boolean Algebras by Terms of Triadic Rejection."

On Thursday afternoon, at a joint session with the Section on Astronomy, J. B. Wilbur read a paper on "The Mechanical Solution of Simultaneous Algebraic Equations," G. D. Birkhoff a paper on "A Conceptual Theory of Atomic Structure," and H. R. Morgan a paper on "Some Problems in Fundamental Astronomy."

For the Section on Mathematics the following officers were elected: *Vice-president of the American Association and chairman of the section,* W. D. Cairns; *members of the committee of the section,* M. H. Stone (elective, retiring in December, 1940), two members of the American Mathematical Society to be announced later (representing the society), C. S. Atchison and H. L. Rietz (representing the Mathematical Association of America).

SECTION ON PHYSICS (B)

(*Reports from Henry A. Barton, Duane Roller, C. F. Brooks, Marsh W. White*)

The meeting of the Section on Physics, presided over by George B. Pegram, vice-president and chairman, was held as usual jointly with the American Physical Society. This year the American Association of Physics Teachers also joined in this session. The meeting program was composed entirely of two invited papers. In the first of these, "Electron Impacts in Gases," John T. Tate, retiring vice-president of the section, reviewed recent results yielded by the general experimental method in which ions produced by controlled electron impacts are identified and studied in a mass spectrograph arrangement. The second paper, presented by F. K. Richtmyer as retiring president of the American Physical Society, was on the subject, "Multiple Ionization of Atoms." He approached the subject from the point of view of x-rays. That is, x-ray spectra of excellent resolution were used to indicate the state of multiple ionization produced in atoms, particularly by electron impact. A very large amount of data accumulated by Professor Richtmyer, his co-workers and others throughout the world was presented, together with a critical summary of conclusions which may now be drawn. This joint session was well attended and unusually interesting.

The American Physical Society's sessions commenced with an innovation, namely, a symposium on "Some Problems in Radiological Physics." This symposium consisted of fifteen invited and contributed papers running through Monday morning and afternoon. These were arranged by Lauriston S. Taylor, of the National Bureau of Standards. The papers dealt in part with radiological technique, emphasizing the difficulty of measuring x-ray and neutron dosage. Various methods of measuring were discussed and one paper gave the results of measurements on the x-ray output of ten high voltage x-ray generators. Some attention was devoted to backward scattered x-rays and also to secondary radiations emitted by filters used in Roentgen therapy. Other papers dealt more particularly with composite radioactive sources of neutrons, and finally there was considerable discussion of the biological effects of radiations of different types and energies.

Owing to the large number of general papers contributed at this meeting it was necessary to hold parallel sessions. While the radiological symposium was going on, eighteen papers on a wide variety of subjects were presented in another room. These dealt with explosions, mammalian body temperatures, electronic phenomena, the charge on the electron, quantum theory, intermolecular forces, nuclear magnetic moments, etc.

On Tuesday afternoon two sessions were again held. One of these was devoted to x-ray and optical spectra, their measurement and their use in the study of matter. The other session was devoted to the atomic nucleus and was made up of papers on neutrons, electron pairs, the interaction between nuclear particles, deuteron bombardment and induced radioactivity.

On Wednesday morning a very interesting session was held in which most of the papers dealt with the theory of magnetism. One paper reported experimental measurements in this field. Another paper on a different subject had to do with energy levels in heavy nuclei. On Wednesday afternoon a number of papers were presented on the subject of atomic masses. These included two outstanding papers by Kenneth T. Bainbridge and Edward B. Jordan which gave the results of very accurate mass spectrographic determinations. Another paper reported an experimental method for separating isotopes by high-speed centrifuging. Finally several important papers dealt with the subject of cosmic rays and their laboratory effects.

At a business meeting held early on Tuesday morning the following officers of the society were elected: R. M. Randall, *president;* Lyman J. Briggs, *vice-president;* W. L. Severinghaus, *secretary;* George B. Pegram, *treasurer;* all the foregoing for the calendar year 1937. For longer terms the following were elected: M. J. Kelly, John C. Slater and Henry A. Erikson, *members of the council;* Kenneth T. Bainbridge, H. P. Robertson and E. O. Wahlin, *members*

of the board of associate editors of The Physical Review.

The American Association of Physics Teachers held its sixth annual meeting from Tuesday through Thursday. One session of invited papers was conducted jointly with the Section on Physics and the American Physical Society. Two sessions were devoted to 27 contributed papers, a number of which were illustrated with actual experimental demonstrations. At a fourth session, chairmen of various committees of the association presented reports as follows: C. J. Lapp, "Examination for Profession of Physicist"; A. A. Knowlton, "Ideal Undergraduate Curriculum"; H. L. Dodge, "Membership"; W. E. Chamberlain, "Physics for Premedical Students"; T. D. Cope, "Preparation in Mathematics"; R. M. Sutton, "Publication of Demonstration Experiments"; P. I. Wold, "Training of Physicists for Industry"; W. H. Michener, "Electric and Magnetic Units and Dimensions."

On Thursday evening a joint dinner was held with the American Physical Society. D. L. Webster, president of the association, and Frederic Palmer, Jr., chairman of the committee on awards, participated in a ceremony in which the association made the first of its annual awards for notable contributions to the teaching of physics to William Suddards Franklin, posthumously. A certificate of award was presented to the family of Professor Franklin and bronze memorial tablets were presented to Lehigh University and to Massachusetts Institute of Technology, the institutions with which Professor Franklin was associated during his most active years.

At the business meeting held on Thursday morning, officers elected for 1937 were announced as follows: *President,* F. K. Richtmyer; *vice-president,* H. B. Lemon; *secretary,* T. D. Cope; *treasurer,* P. E. Klopsteg; *members of the executive committee,* F. A. Saunders and Alpheus W. Smith. A committee was appointed to investigate the proposal that the association sponsor an annual, national examination in physics at the baccalaureate level. Another new committee will study physical terminology, symbols and abbreviations. Other business included the report of the treasurer and the announcement that the official journal, *The American Physics Teacher,* will henceforth appear bi-monthly instead of quarterly.

The American Meteorological Society held five sessions from Monday to Wednesday. The first session included a discussion by A. F. Spilhaus of experimental results on the kinematics of jet streams in a rotating system, a description of detailed variations of frosts by Benjamin Holzman as revealed by quarter-hourly observations in two counties of Oklahoma, a discussion of "The International Classification of Clouds and States of the Sky," by C. F. Brooks, and how hourly weather maps can be made from teletype reports for use in local forecasting and teaching by W. O. J. Roberts.

Tuesday morning and the first part of the afternoon were devoted to radio-meteorographs and other meteorological apparatus. A feature of the annual science exhibition was the largest exhibit of meteorological equipment assembled anywhere in the United States since 1889. This exhibit was described by S. P. Fergusson, chairman, and various portions of it by other speakers, notably Lyman J. Briggs, who presented the details of the meteorological equipment used on the stratosphere flight of *Explorer II.* A. H. Thiessen outlined a proposal for a permanent exhibit of meteorological instruments. Most of the time in this instrument portion of the program was devoted to descriptions of the five types of American radio-meteorographs on display and a demonstration of two of them in actual ascent. These two were released almost simultaneously and as they rose reported the pressure, temperature and humidity every half minute or oftener. The radio transmitters worked on 68 and 55 megacycles and so could be received simultaneously by the two recorders. Both meteorographs were heard for more than an hour and reached a height of 18 km. The base of the stratosphere was found at 14 km at a temperature of $-70°$ C. Only a sampling of the record made by the National Bureau of Standards-Weather Bureau instrument was evaluated during the ascent, for the record was fed out very rapidly on a tape. The significant points of the entire ascent by the Harvard Blue Hill instrument were evaluated during the ascent, since the record was fed out by the recorder in graphical form. This record was plotted on an adiabatic chart and shown to the meeting early in the afternoon only three hours after the ascent, and compared with the results obtained by aerometeorograph on an airplane which rose from the U. S. Naval Air Station at Lakehurst, N. J., at about the time the balloons were released from Atlantic City. Up to 5 km, the height reached by the airplane, the temperatures indicated by both means were the same within one Centigrade degree. The humidities in the lower levels over Atlantic City were appreciably higher than those at Lakehurst, owing to a damp wind from the sea and a thick layer of clouds at the coastal station.

In the afternoon session J. B. Kincer presented an extraordinary summary of the national loss from hail, windstorms, drought and other weather vagaries. W. H. Alexander described what was being done to prevent floods in Ohio, especially the new Muskingum Valley project. The climatic belts of Georgia were described by G. W. Mindling, who corrected a long-standing error giving northern Georgia temperatures belonging to high latitudes in the United States. H.

Landsberg summarized nuclear climatology, showing the variations in condensation nuclei in the atmosphere over the earth's surface and at different heights.

Wednesday morning was devoted largely to the annual business meeting, but two sound motion pictures, recently released by the Department of Agriculture, brought out the Weather Bureau's fire-weather work and its flood-warning system. The Potomac flood of March, 1936, provided most of the illustrative material for the latter. F. Graham Millar showed how the complexities of evaporation could be expressed adequately in a theoretical formula.

The Wednesday afternoon session, which was joint with the Section on Astronomy, was chiefly on weather variations and long-range forecasting. H. H. Clayton indicated that on account of slowly moving centers of weather departure one could not expect to find continuing periodicity in the weather at a single station. But Dinsmore Alter, in presenting a new and very rapid form of periodogram analysis, showed that definite periods did exist in the rainfall of certain climatically homogeneous districts. Warren M. Persons, employing rigorous statistical analysis upon the correlation between seasonal weather in widely separated parts of the earth, showed that the correlation coefficients of various sizes which have been found were almost exactly equal in their frequency distribution according to size to what should be expected purely on the basis of chance. Measurements of ultraviolet radiation on Blue Hill were summarized by R. Wexler, and certain phases of variation of ions in the atmosphere were compared with solar phenomena by H. T. Stetson, which were illustrated by motion pictures of solar meteorology by the McMath-Hulbert Observatory of the University of Michigan.

In the annual meeting the secretary and treasurer reported satisfactory growth of membership and resources. The annual election continued in office C. F. Brooks as *secretary* and L. T. Samuels as *treasurer*, and put the following as *councilors* for the next three years: J. A. Fleming, W. J. Humphreys, J. B. Leighly, G. R. Parkinson, Andrew Thomson. W. R. Gregg was named to complete the unexpired term of Montrose W. Hayes, deceased.

Sigma Pi Sigma, physics honor society, held its annual luncheon on Wednesday. Thirty members and guests attended, with F. K. Richtmyer, retiring president of the American Physical Society and an honorary member of Sigma Pi Sigma, as guest of honor. The executive council of the society held its sessions on the afternoon and evening of Tuesday.

SECTION ON CHEMISTRY (C)

(*Report from J. H. Simons*)

The meeting of the Section on Chemistry began with a joint session on Tuesday afternoon with the Section on Education and the Division of Chemical Education of the American Chemical Society for a symposium on "The Preparation of Teachers of Chemistry." Two papers were given, one by J. H. Simons, who expounded the chemist's point of view on this topic, and the other by William S. Gray, of the Department of Education of the University of Chicago, who expressed the educator's point of view. These papers were then discussed by Ross A. Baker for the scientific view-point and S. Ralph Powers for the educational.

Irving Langmuir presided at the Wednesday session of the section. The first paper was by C. H. Kunsman, who discussed "Recent Chemical and Technological Developments in Fertilizers." He showed that chemical research had made available to the farmer continually less costly plant foods and ones more adaptable to field use. He also indicated the direction that present research is taking both to reduce the cost of fertilizers and to improve their utilization.

Under the title "Entropy and Other Physical Properties of Isoprene," Norman Bekkedahl and Lawrence A. Wood described the results of very precise measurements on extremely pure isoprene. These included not only thermodynamic but also other physical properties. As this substance is related to natural rubber and as the same workers have made precise thermodynamic measurements on the latter, including its heat capacity to lower than 20 K., application of thermodynamic laws enable the properties of the polymerization reaction to be calculated. "Hydrogen and Oxygen Isotopic Abundance Ratios in Natural Compounds" was the title of a paper by Malcolm Dole, R. B. Gibney, J. L. Gabbard and R. L. Slobod. Dr. Dole stated that his work showed that the isotopic composition of hydrogen in natural compounds such as benzene and cholesterol are the same as in Lake Michigan water. The isotopic composition of oxygen, however, was found to vary from Lake Michigan water for ocean water, spring water and water condensed from the atmosphere.

The first afternoon paper was the address of the retiring vice-president of the section, Moses Gomberg. Under the title of "Free Radicals" he first traced the history of these active substances which vary all the way from those that are relatively stable, like the triphenylmethyl compounds, to compounds like free gaseous methyl which has a relatively short half life period. He stated that he had recently made free radicals of intermediate half life periods of about two minutes. He explained how recent work on magnetic susceptibility had confirmed older measurements of the equilibrium between the monomer and dimer in the triphenylmethyl type of free radicals in solution, given a check on the heat of dissociation of about 12,000 calories, shown the existence of free radicals in the

crystalline state, and shown in some compounds the existence of a free radical with two unpaired electrons. He also spoke of the quantum mechanical explanation of free radicals and compared this method of correlation with an older picture of organic chemistry to explain the properties of the triphenylmethyl radical having bromine atoms in the para position.

Theodore F. Zucker gave a paper on the "Purification of Vitamin D from Natural Sources" by T. F. Zucker and E. G. H. Simons. He explained his method and the properties of the substance obtained. "The Value of the Acid Silver Nitrate Reaction as a Test of Ascorbic Acid Results" was the title of a paper by A. Giroud and C. P. Leblond. Extensive work, which showed the very considerable value of this test, was described; and its limitations were also explained.

SECTION ON ASTRONOMY (D)

(Report from Harlan T. Stetson)

Three sessions of the Section on Astronomy were held. On Wednesday afternoon there was a joint session with the American Meteorological Society, at which papers on the borderline field between meteorology and astronomy were presented. The question of weather cycles of long period in connection with solar radiation and sun-spots was discussed from the point of view of a world analysis of the distribution of "highs" and "lows" by H. H. Clayton. Dinsmore Alter informed the group of a new form of periodogram analysis recently perfected at the Griffith Observatory, and Warren M. Persons stressed the dangers of faulty interpretation of correlation coefficients in any statistical analysis. Among other papers presented of interest to astronomers and meteorologists was the record of measurements of ultra-violet radiation at the Blue Hill Observatory by R. Wexler and C. F. Brooks, director of the observatory. The session was closed with a showing of a motion picture film of solar prominences, illustrating remarkable circulations in the atmosphere of the sun, that was taken by R. R. McMath, of the McMath-Hulbert Observatory, attached to the University of Michigan.

The Thursday morning session was the occasion for the presentation of a significant paper by Charles Hetzler, of the Yerkes Observatory, on "An Infra-Red Stellar Survey," portraying the remarkable findings of invisible or "ghost" stars through infra-red photography. The new interests in the study of solar activity and radio conditions brought a paper from R. S. Richardson, of the Mount Wilson Observatory. Dr. Richardson gave a comprehensive account of the relation between fade-outs and solar eruptions that had been observed at Mount Wilson during the last year. Discovery by Dr. Dellinger, of the Bureau of Standards, of an apparent 54-day interval between such phenomena has led to a systematic observation of the sun at the time of expected reoccurrences. Dr. Richardson finds that while many of the fade-outs have been accompanied by simultaneous outbursts in the solar chromosphere, there are occasions when such outbursts have apparently no identifiable counterpart in ionospheric disturbances.

The Thursday afternoon session closed the astronomical program with three invited papers, the Section on Mathematics joining with the Section on Astronomy in this program. J. B. Wilbur, of the Massachusetts Institute of Technology, informed the group of the perfection of a device for the mechanical solution of simultaneous algebraic equations. The machine thus far constructed is capable of solving nine equations with nine unknowns.

George D. Birkhoff, of Harvard University, presented to the astronomers and the mathematicians in attendance a new conceptual theory of atomic structure. With the success of its application to the hydrogen atom already achieved, Professor Birkhoff gave hope for a new picture of the universe with remarkable philosophical implications. His theory would avoid some of the difficulties of current atomic theories, and the vague and somewhat unsatisfactory picture that wave-mechanics have to offer.

The address of the retiring vice-president of the Section on Astronomy with the title, "Some Problems in Fundamental Astronomy," by H. R. Morgan, closed the session. Dr. Morgan gave a lucid and comprehensive summary of the many unsolved problems in this branch of astronomy, somewhat subordinated to-day to astrophysical questions. It is anticipated that this address will be printed in full.

The astronomy exhibit sponsored by the section was made particularly effective this year through the cooperation of the Carnegie Institution of Washington and the Hayden Planetarium of the American Museum of Natural History. The centerpiece of the exhibit was the model of the 200-inch telescope of the California Institute of Technology, which was loaned through the courtesy of the Westinghouse Company of Pittsburgh. Three-dimensional stellar models loaned by the Buffalo Museum of Science contributed much to popular interest in the astronomical display, as did also the grinding of telescopic mirrors by two representatives of amateur interests in astronomy in the New York section.

SECTION ON GEOLOGY AND GEOGRAPHY (E)

(Report from Kirtley F. Mather)

The section held one session on Thursday morning. Inasmuch as none of the affiliated organizations were in session in Atlantic City, the attendance was small. Moreover, the retiring vice-president, Walter E. Mc-

Court, had unfortunately been prevented by ill health from preparing the customary address. Nevertheless, the meeting proved to be of considerable significance, and much interest was manifested in the extended discussions of the papers presented. Among them, the ideas concerning flood control in the Connecticut Valley suggested by Edward L. Troxell, of Trinity College, were considered extensively, although there was no general agreement as to the effectiveness of the proposed canals and dikes. William C. Darrah's announcement of the success which he has achieved in his laboratory studies at Harvard University concerning fossilized spores in coal by means of nitrocellulose peels apparently opens a broad field for paleobotanical research. The physiographic study of Blackfoot Valley presented by George R. Mansfield, of the U. S. Geological Survey, stimulated an extended discussion.

SECTION ON ZOOLOGICAL SCIENCES (F)

(*Reports from George R. La Rue, H. B. Goodrich, Clarence E. Mickel, Ernest N. Cory, Horace W. Stunkard*)

The Section on Zoological Sciences met in joint sessions with the American Society of Zoologists on Tuesday, Wednesday and Thursday. The annual dinner for the Zoologists was held on Wednesday night. Following the dinner Ross G. Harrison gave the vice-presidential address on the subject, "Embryology and Its Relations." Dr. Harrison touched upon recent developments in embryology, particularly those that have occurred since the discovery of the organizer. The relations of embryology to genetics and to physiology were discussed, and some of the difficulties and shortcomings of embryological methods noted. The great success of genetics, while in one sense an aid to the understanding of development, may on the other hand become a danger, in that it may direct attention away from the purely ontogenetic processes which genetics can in no wise wholly explain. There is need for a real physiology of development which will study the actual physical and chemical changes that take place in the differentiating cytoplasm and will explain their localization. This will have to take into account the properties of protein molecules, their diversified chemical activities, their specific configuration and their tendency to assume a para-crystalline arrangement in the aqueous systems in which they occur. The possibility of x-ray analysis of the changes taking place during development was pointed out.

The American Society of Zoologists held its thirty-fourth annual meeting jointly with the section from December 29 to 31. The symposium on "Experimental Populations," held jointly with the Ecological Society of America and arranged by W. C. Allee, was held on Tuesday afternoon. Papers were given by Willis H. Johnson, Thomas Park, A. M. Banta and Raymond Pearl. There was also a joint session with the Genetics Society of America on "Genetics and Development" at which papers were given by E. E. Just, Edmund W. Sinnott, G. W. Beadle and Victor C. Twitty. The special session on "Biological Effects of Radiation," arranged by W. C. Curtis, elicited much discussion. An important joint session with the Society of Cell Physiologists, arranged by Robert Chambers, was held on Wednesday afternoon. Among the regular sessions that on embryology was especially notable for the important papers presented.

The annual Biologists' Smoker was held on Tuesday evening with an estimated attendance of 800. The Zoologists' dinner on Wednesday evening, with 270 in attendance, was addressed by Ross G. Harrison, vice-president of the Section on Zoological Sciences, who gave an interesting informal survey of recent progress and future prospects of the science of embryology. At the annual business meeting held on Wednesday at noon the following officers were elected: *President,* F. L. Hisaw; *vice-president,* Helen D. King; and *secretary,* Elmer G. Butler. The sessions of the society concluded on Thursday at noon, there having been presented 120 papers exclusive of those read by title.

The Entomological Society of America held its thirty-first annual meeting from Monday through Wednesday. During the regular sessions there were presented 36 papers. A joint symposium was held on Monday afternoon with the American Association of Economic Entomologists on "Insects Affecting Man." L. O. Howard, pioneer in medical entomology and formerly chief of the Bureau of Entomology, presided at the symposium. The annual address was given by Edith M. Patch, of the University of Maine. Dr. Patch, who has been in charge of entomological work at the Maine Agricultural Experiment Station for many years, spoke on "Without Benefit of Insects." She said that too much emphasis has been directed to the fact that certain insects are injurious to man, his crops and domestic animals and too little to the fact that man is dependent on the insects for the pollination of plants which produce fruit, seeds, flowers and other commodities which are useful to him. The wholesale killing of insect life resulting from control campaigns in which large areas are dusted or sprayed with toxic materials by means of airplanes and other mechanical equipment has already exterminated such a large proportion of the beneficial native insect life that it is necessary to introduce honey bees for the purpose of pollinating the flowers of fruit trees. In certain localities some other plants have already become rare because their insect pollinators have been

eliminated from the native fauna. The time may not be far distant when it will be necessary to inaugurate conservation projects for the preservation and cultivation of insects necessary for the pollination of plants in order to insure the production of fruit crops and other products of the vegetable world useful to man. It may even come about that in the future more entomologists will be concerned with the preservation and cultivation of beneficial insects than are now engaged in studies and projects designed to destroy the injurious insects.

The presiding officer at the meeting was H. B. Hungerford. Officers for 1937 are: *President,* O. A. Johannsen; *first vice-president,* A. G. Ruggles; *second vice-president,* Alfred C. Kinsey; *secretary-treasurer,* Clarence E. Mickel.

The feature of the forty-ninth annual meeting of the American Association of Economic Entomologists was the joint symposium of the Economic Entomologists and the Entomological Society of America on "Insects Affecting Man and Animals," presided over by L. O. Howard. The principal speakers were T. J. Headlee, "Mosquitoes and Their Control"; L. L. Williams, "Mosquitoes and Malaria"; W. E. Dove, "Myiasis of Man"; William Robinson, "Some Therapeutic Uses of Insects and Their Products"; and R. R. Parker, "Ticks in Relation to Man." These papers were discussed by Robert Glasgow, F. C. Bishopp, O. R. Causey, W. A. Riley and Robert Matheson.

A program of 99 papers was distributed over three sections and the general meetings. Approximately three hundred members of the American Association of Economic Entomologists and of the Entomological Society of America attended the annual Entomologists' dinner, which was addressed by Edith M. Patch, E. A. Mechling and L. O. Howard. Two hundred and fifty members of the association registered for the meetings. Fifty-three new members were elected, and Hachiro Yuasa, president of Doshisha University, Kyoto, Japan, was elected a foreign member.

F. C. Bishopp, of the Bureau of Entomology and Plant Quarantine, was elected president and S. W. Bilsing, College Station, Texas, first vice-president. Additional vice-presidents are: E. J. Newcomber, Pacific Slope branch; W. E. Anderson, Cotton States branch; H. N. Worthley, Eastern branch; L. H. Worthley, section of plant quarantine and inspection; E. J. Anderson, section on apiculture; and T. H. Parks, section on extension.

The American Society of Parasitologists held its twelfth annual meeting from December 29 to 31 inclusive under the presidency of Robert Hegner. The program contained 63 titles, the same number as that of the previous year, and consisted of papers on various aspects of parasitology, tropical medicine and public health. The program of the first day was made up of papers which dealt with nematode parasites, and information on morphology, distribution and life history of various species was presented. Noteworthy observations were made concerning the physiology and nutrition of these worms. Probably the outstanding contribution was reported by Maurice C. Hall and B. F. Collins, of the U. S. Public Health Service, tracing the incidence and etiology of trichinosis in the United States.

The demonstration session, which has become a special feature of the annual meeting, was held on Wednesday morning. The papers presented dealt with various phases of parasitology, especially the distribution, life history, pathology and control of helminth parasites from various parts of the world. The Wednesday morning session was concluded by the presidential address. President Hegner spoke on the subject, "Parasite Reactions to Host Modifications," and the address will be published in the next number of the *Journal of Parasitology.* The Parasitologists' luncheon was held on Wednesday and 99 members of the society were present. It was followed by the annual business meeting of the society. The Wednesday afternoon program was devoted to papers on protozoology and the Thursday morning session to contributions on medical entomology and parasitic flatworms.

At the annual business meeting the following officers were elected for 1937: *President,* George R. La Rue; *vice-president,* David H. Wenrich; *secretary* (to serve for two years), Horace W. Stunkard; *treasurer* (to serve for two years), Gilbert F. Otto; *members of the council* (to serve for four years), Justin Andrews and Norman R. Stoll.

SECTION ON BOTANICAL SCIENCES (G)

(*Reports from S. F. Trelease, L. C. Petry, Paul Weatherwax, Jason R. Swallen, H. P. Barss, Walter F. Loehwing, David H. Linder, Edgar T. Wherry, R. A. Studhalter*)

The Section on Botanical Sciences met in joint session with associated societies on Tuesday afternoon. More than four hundred and fifty botanists attended this unusually interesting session. E. W. Sinnott delivered the retiring vice-presidential address for the section on the subject "Morphology as a Dynamic Science." This address was followed by a symposium on "Recent Developments in Plant Sciences." W. M. Stanley discussed his biochemical studies on the virus of tobacco mosaic, for which he was awarded the annual thousand-dollar prize of the American Association for the Advancement of Science. E. J. Lund

summarized ten years' research on electric polarity in plants. Annie M. Hurd-Karrer described new and interesting phases of her research on the selenium problem.

The Botanical Society of America held its thirty-first annual meeting from December 29 to 31. The forenoons were mainly occupied by the reading of contributed papers at meetings of the three sections, and various joint sessions were held in the afternoons. The annual dinner for all botanists was held on Wednesday evening with an attendance of 301. C. Stuart Gager, president of the Botanical Society of America, presided at the dinner and introduced Aven Nelson, retiring president, who spoke on "Discipleship." At this meeting it was announced that Marshall A. Howe, acting director of the New York Botanical Garden, who died on December 24, was president-elect of the society and that the council had filled the vacancy caused by his death by the election of E. W. Sinnott. Other officers of the society for 1937 are: *Vice-president,* Loren C. Petry; *secretary,* George S. Avery, Jr.

At a meeting held on Wednesday evening a paleobotanical section of the society was organized by the election of the following officers: *Chairman,* A. C. Noé; *secretary,* W. C. Darrah; *representative on the editorial board of the American Journal of Botany,* C. A. Arnold.

The general section met in three sessions. The papers presented at the session on Tuesday forenoon were mostly physiological. Six of these dealt with problems of growth and differentiation, particularly as affected by auxins. Harry N. Stoudt summarized the problem of the production of plantlets from the leaves in the Crassulaceae. His study showed that the various species may be arranged in a graded series, depending upon the degree of development attained by the young plantlets while the leaf is still attached to the parent plant. Mel T. Cook reported that, because of a fungous disease of the immature seeds, the two timber species of *Magnolia* in Puerto Rico have practically ceased to reproduce. Michael Levine reported further work on the nature and causes of plant tumors. The tumor-producing effects of various extracts of cultures of *Bacterium tumefaciens* were tested on a number of plants, and, although abnormal growth resulted, none of these were comparable with those produced directly by the organism itself. It was pointed out that the results fell short of the effects produced in a similar way with animal tumors.

Papers dealing with morphological problems constituted the program of Wednesday forenoon. Kenneth W. Hunt discussed the homology between carpel and foliage leaf as illustrated by *Drosera* and *Reseda,* citing evidence to show that the carpel has been derived from parts of a dichotomous branch system through a stage represented by a three-lobed, open megasporophyll. C. C. Doak showed that in the cotton plant each pollen tube is usually confined to a single carpel, but that a considerable number cross over to adjacent carpels in the pistil. J. T. Buchholz added one more chapter to his long series of studies on the embryos of the two species of *Sequoia.* He showed that in *S. sempervirens* the seeds mature and are shed the first season, while in the Big Tree, *S. gigantea,* the cone requires at least three years for complete development and may continue to live several years longer. This species was also shown to have a complicated system of multiple embryos. It was suggested that the large number of constant differences between the two species would amply justify their being placed in separate genera. Phyllis L. Cook contributed a short paper filling in what was not already known of the latter part of the development of the female gametophyte in *Thuja occidentalis.* LaDema M. Langdon discussed the fruits and carpellate flowers of the Amentiferae and concluded that two possible explanations of the origin of the group, one from a pomaceous Rosalean stock and one from the Pteridosperms, had about equal merit. Wayne E. Manning showed an arrangement of the genera of the Juglandaceae which suggests the evolution of their inflorescences from a panicle like that of the Anacardiaceae. Three papers dealt with morphological features of the Pteridophytes. One of these, by A. G. Lang, gave interesting new details of the structure of the sperm of *Marsilea.* By disintegrating sperms with hot water, the relations of the various parts are shown more clearly than when seen in ordinary microscopic preparations. The flagella were described as arising not from the externally visible blepharoplast, but from one of two parallel strands of specialized substance located in a band which extends the full length of the sperm.

The program of the final session consisted of two groups of papers, one dealing with cytology and the other with paleobotany. Papers by Florence L. Barrows and Wanda K. Farr made further contribution to what is known of the nature of the particles which make up the cell wall. The first of these papers showed that the cellulose particles which they have had under observation occur in representatives of all the four great divisions of the plant kingdom. The second, by taking advantage of the unusual size and form of the cells of *Valonia,* showed that the cellulose particles are arranged in two series of fibrils crossing at a characteristic angle to form a lattice and adhering to the cell wall by means of a colloidal cementing material. A paper by Harold A. Senn gave a classification of the Leguminosae based upon chromosome numbers. The evidence from the chromosomes indicates that the woody and perennial forms are of more

recent origin than the annual forms. Mark W. Woods and Ronald Bamford demonstrated use of the form of the chromosomes as an aid to classification in the genus *Tulipa*. Using examples from Cretaceous and Tertiary plant remains, C. A. Arnold pointed out a number of errors of identification due to the failure of investigators to correlate their work with modern work on the taxonomy of living plants. W. C. Darrah explained the use of the celloidin peel technique in the study of various kinds of plant fossils, including impressions, and illustrated his paper with some striking preparations made by this method.

Officers of the section for the coming year are: *Chairman,* E. N. Transeau; *secretary,* Paul Weatherwax; *representative on the editorial board of the American Journal of Botany,* Charles Thom.

The physiological section met in three sessions for the reading of contributed papers and in a joint session with the American Society for Horticultural Science and the American Society of Plant Physiologists at which four invited papers were offered. At the Tuesday morning session various aspects of the relatively new subject of plant growth regulators occupied most of the program. K. V. Thimann offered evidence that the inhibitory effects of auxins upon roots are not accompanied by thickening of the roots, and that inhibition of growth of buds is not necessarily accompanied by increased growth of other organs of the plant. A. E. Hitchcock and P. W. Zimmerman reported that the use of various indole and naphthalene derivatives in water solution induced root formation in a wide variety of plants, including many of commercial importance that have been regarded as difficult to root. The same authors also reported evidence that the growing stem tip has a regulatory influence on the development of underground stems and tubers. A paper by F. G. Gustafson reported that in five species of plants pollen extracts applied to the ovaries of unpollinated flowers resulted in enlargement of the ovaries and, in some cases, in the formation of normal but seedless fruits.

At the Wednesday afternoon session two papers dealing with the effects of freezing upon plant cells were read. B. J. Luyet and S. M. Grell described the effects of freezing upon the various protoplasmic constituents of the cell when subsequently treated in an ultra centrifuge. Irene Stuckey correlated the susceptibility to freezing with the presence of free water. P. J. Kramer and J. R. Jester gave data indicating that the length of the growing season in woody plants is influenced more by length of day than by seasonal variations in temperature. Lewis Knudson demonstrated the results of experiments on the chloroplasts, indicating that they exhibit definite osmotic properties and evidently possess a semi-permeable membrane. E. M. Palmquist reported evidence that carbohydrates and an introduced dye (fluorescein) can move simultaneously in opposite directions in the same phloem tissue.

At the Thursday morning session two papers dealt with the effects of environmental conditions upon cell wall structure. Thomas Kerr showed a correlation between the lamellar structure of the cotton hair wall and the diurnal variation in temperature. This conclusion was supported by D. B. Anderson and J. H. Moore, who reported the absence of such lamellation in cotton hairs grown under constant illumination and temperature. Other speakers at these three sessions discussed seed dormancy and germination, the effects of ultra-violet radiation upon bacteria, some properties of a growth substance affecting Rhizobium, the effects of various environmental factors upon the structure and composition of green plants, and other subjects.

On Wednesday forenoon the physiological section met in joint session with the American Society for Horticultural Science and the American Society of Plant Physiologists. The program consisted of a symposium on the general subject of "Mineral Nutrition of Plants." G. T. Nightingale discussed the relation of potassium and calcium supply and availability to nitrogen metabolism. J. E. McMurtrey, Jr., described the distinctive effects in tobacco culture of a deficiency of various mineral nutrients. W. H. Chandler discussed the importance of zinc as a plant nutrient. O. F. Curtis dealt with the general question of the translocation of nitrogen and mineral elements in plants.

Officers of the physiological section for 1937 were announced as follows: *Chairman,* E. F. Hopkins; *vice-chairman and representative on the editorial board of the American Journal of Botany,* H. S. Reed; *secretary-treasurer,* Paul R. Burkholder.

The systematic section held three morning sessions at which 19 papers were presented. On Tuesday morning there was an interesting discussion of the present tendency to give Latin names to small variations of a species with resultant quadrinomials, quintinomials, etc. The Wednesday morning session was devoted to reports on certain local floras and included an invitation paper on a method of composite range-mapping as applied to the pine barren region of southern New Jersey. On Thursday technical papers on various groups of plants were presented. The interrelations of taxonomy and other branches of botany were discussed at the symposium on Wednesday afternoon. The invitation papers constituting this program were given by Edgar Anderson, representing cytology; Ralph W. Chaney, paleobotany; and E. D. Merrill, ethnology. Officers of the systematic section for 1937 are: *Chairman,* T. G. Yuncker; *secretary,* Winona H. Welch.

The twenty-eighth annual meeting of the American Phytopathological Society, held from Monday through Thursday, was outstanding. More than two hundred members registered. With the election of 139 new members at the meeting the active membership roll reached 965. G. W. Keitt, of the University of Wisconsin, was elected *president;* H. W. Anderson, of the University of Illinois, *vice-president;* and Charles Chupp, of Cornell University, *councilor.*

The scientific program of 99 prepared papers was less congested than in previous years and of high quality. W. M. Stanley, of the Rockefeller Institute, presented at the joint session with the Section on Botanical Sciences "Chemical Studies on the Virus of Tobacco Mosaic." The paper by Helen Purdy Beale, Boyce Thompson Institute, on "The Relationship of Intracellular Inclusions to Crystalline Tobacco Mosaic Virus Material," awakened great interest. Both these and other virus papers indicated that recent work in the plant virus field is rapidly opening hopeful avenues of approach to some of nature's most perplexing problems.

R. S. Kirby gave an effective demonstration of what good natural color motion pictures can do to carry needed facts about plant diseases and practical control convincingly to the grower. A paper by John Monteith on "The Use of Aniline Dyes in the Control of Rhizoctonia" as well as a number of other papers opened up a range of new possibilities in chemical control of diseases. W. M. Banfield presented convincing new evidence of the spread of the spores of the hard-fought Dutch elm disease within the tree through the sap stream.

Most stimulating was the joint symposium with the Genetics Society of America on Thursday morning on "Breeding for Disease Resistance in Plants and Animals." Joint sessions of interest and value were also held with the Mycological Society of America and with the Potato Association of America.

The necessity that adequate provision be made by this and other nations for biologically sound, effectively conducted measures to hold in check the destructive spread of plant diseases was brought out in papers by Lee A. Strong, chief of the U. S. Bureau of Entomology, and J. F. Adams, of the National Plant Board, at a conference held on Monday evening under the auspices of the committee on foreign plant diseases and quarantines. The problem of stopping the worldwide dissemination of all kinds of crop diseases was opened up in a paper by M. T. Mann, New York (Geneva) Experiment Station, and a subcommittee was appointed to work on this problem. The society endorsed as sound the recent resolution of the National Plant Board calling for the establishment by the 1937 Congress of a continuing plant pest fund to be used only to meet unforeseen needs in dealing with crop pest and disease emergencies. The society went on record as urging that funds also be made available to begin complete eradication of the potato wart disease from the relatively few localities where it has become established in the United States.

At a round table conducted by the committee on coordination of research and extension work, the complexities of the spray and dust injury problem were discussed. The executive committees of the Tobacco Disease Council and the Cotton Disease Council met on Tuesday and Wednesday evening, respectively, and planned further coordinated activities. The former group decided to arrange, if possible, within a short time to call a general conference of state and federal workers on the root knot nematode with a view to reviewing the situation and planning for mutual assistance in a more intensive attack on the problems created by this eelworm, which is considered the most persistent, widespread and costly destroyer of all kinds of crops throughout the southern half of the United States. The subcommittee on tobacco virus diseases presented for review by the group and eventual release to all interested states a carefully prepared, concise, authoritative statement of the tobacco mosaic situation and of the measures demonstrated as effective in practical plantbed and field control.

Important legislation by the society repealed the life membership provision of the constitution; removed, effective on December 31, 1936, the $1 per page levy on contributors for articles published in the official journal *Phytopathology;* pledged the membership to support a rigid editorial policy looking to conciseness and authorized the editor-in-chief and business manager to institute, if necessary, other measures in the interest of the economy in publication; ordered the future printing in the journal at the expense of the society of abstracts of all papers presented at the annual meeting; established a committee on memberships and subscriptions and a committee on donations and legacies, replacing and enlarging the powers of the committee on permanent endowment. The society voted to support, as a donor, the International Centraalbureau voor Schimmelcultuur at Baarn, Holland.

The Pacific Division was instructed to take charge of the summer meeting to be held in connection with the American Association for the Advancement of Science meeting in Denver. The Canadian invitation for the society to meet in Ottawa in the summer of 1938 was enthusiastically accepted.

The Phytopathologists' dinner, attended by 312, will be remembered for the cleverly worded presentation to the society by F. A. Wolf, Duke University, of a curiously wrought gavel and for the original and highly entertaining program conducted by a group of members headed by Wm. H. Martin, R. P. White and W. H. Weston.

The American Society of Plant Physiologists held its thirteenth annual meeting from Tuesday to Thursday. The society participated in joint sessions with the Section on Botanical Sciences, the American Society for Horticultural Science and the Physiological Section in a program on mineral nutrition, including minor elements, and with the Ecological Society of America in a discussion of light and techniques for quantitative measurement.

On Tuesday evening the society held its annual banquet, with R. B. Harvey acting as toastmaster, at which A. E. Murneck's retiring president's address, "Recent Advances in Physiology of Reproduction of Plants," was read by the vice-president, O. F. Curtis, in Dr. Murneek's enforced absence. The election of D. T. MacDougal, of the Carnegie Institution, as an honorary Barnes life member of the society was made in recognition of his services to American plant physiology dating from the very beginning of the present century with the following citation:

D. T. MacDougal was chosen the recipient of the Charles Reid Barnes life membership award because on every ground he is, at the present time, the most obvious nominee for this honor. Only a few of his many qualifications can here be enumerated. For a number of years during the early history of plant physiology in America, Dr. MacDougal was one of not more than four or five plant physiologists in this country, contemporary with Dr. Barnes, and they were good friends. He deserves the credit along with Dr. Barnes for having initiated that early work in plant physiology in the United States. His text-book published in 1901 was the first text-book of plant physiology published in America, and this book did much excellent service for almost a decade before the advent of another book on this subject by an American author.

C. A. Shull announced the selection of Kenneth V. Thimann as the recipient of the Stephen Hales prize in recognition of his contributions in the field of protein chemistry and hormone physiology. He was tendered the diploma and the following citation:

In recognition of his service to the science of plant physiology the American Society of Plant Physiologists now confers the Stephen Hales prize for 1936 on Kenneth V. Thimann; contributor to fundamental knowledge in the complex and difficult subject of the chemistry of proteins; brilliant investigator in the comparatively new but rapidly expanding field of plant hormones, their chemical identity, formation and distribution within the plant, and their function and mode of action in the control of growth and development; a scientist whose achievement is representative of the highest type of endeavor in his sphere of activity.

Dr. Shull, as editor of *Plant Physiology*, announced plans for the publication during 1937 of "festschrift" issues of the journal in recognition of the contributions by certain of its corresponding members. The banquet concluded with moving pictures of the International Botanical Congress held at Amsterdam in 1936 shown by the society's official delegate, Walter F. Loehwing.

The general program on "Morphology as a Dynamic Science" with the Section on Botanical Sciences was of particular interest to the physiologists because of the excellent way in which structure was interpreted in terms of function. The symposium on "Carbon-dioxide Assimilation" included the description of a technique employed by Dr. Heinicke, of Cornell University, for enclosing entire apple trees in air-tight cages for the quantitative study of their photosynthesis and respiration. After describing the novel techniques employed for his studies he reviewed the course of photosynthesis and respiration continuously over a period of an entire year, bringing out the relationship of foliage development and abscission to the processes of growth and fruit formation. On this same program E. D. McAlister and W. H. Hoover, of the Smithsonian Institution, described an important technique for the quantitative measure of carbon dioxide in the presence of other gases. The procedure is unique both in reference to speed and sensitivity and the fact that analysis can be made in complex mixtures of gases which do not show an absorption band in the infra-red. The results included the first quantitative measure of photosynthesis within a few seconds after illumination of higher plants as well as the independence of respiration and illumination indicating that light has no immediate direct effect upon respiration. The findings of these authors also correlate much of the previous work on fluorescence of chlorophyll with the results reported by Franck and Kautsky on higher plants.

The growth-retarding and strong tropic effect of neon light was described by G. O. Burr. The program concluded with a description of the ratio of chlorophyll *a* to chlorophyll *b* and the relation thereof to the mechanism of photosynthesis by O. L. Inman, of Antioch College. The society has shown a very rapid growth and its program shows commensurate expansion and participation by its members.

The Mycological Society of America held its fifth annual meeting from December 29 to 31, with H. M. Fitzpatrick in the chair. At the business meeting reports presented by the secretary-treasurer and by the managing editor of *Mycologia* showed the society and its journal to be in sound financial condition. Its membership is now 377 and shows a definite increase over that of last year. New officers elected for 1937 are: *President,* John Dearness; *vice-president,* L. O. Overholts; *councilor,* H. M. Fitzpatrick, who also was elected *historian* by the council. The council elected J. N. Couch to serve a five-year term as *associate edi-*

tor of *Mycologia*. Through the council the support of the society was given to the Centraalbureau voor Schimmelcultuur at Baarn, Holland. The secretary gave a brief account of the very successful summer foray held at the Mountain Lake Biological Laboratory in Virginia from September 2 to 5. Joint sessions were held with the American Phytopathological Society and with the Section on Botanical Sciences. The retiring president, H. M. Fitzpatrick, gave an address on the "Historical Background of the Mycological Society of America," tracing its origin from its beginnings as part of the Section on Botanical Sciences of the American Association for the Advancement of Science. In addition to the president's address, 41 papers were submitted for presentation, covering the major fields of general interest, such as morphology, physiology, cytology, genetics and medical mycology.

The American Fern Society met on Friday morning. The program consisted of a symposium on "New Jersey Ferns," participated in by M. A. Chrysler, of Rutgers University, Robert T. Clausen, of the Bailey Hortorium at Ithaca, James L. Edwards, of Montclair, N. J., and Edgar T. Wherry, of the University of Pennsylvania. The geographic relations of about 75 species of ferns and fern-allies were discussed, and it was pointed out that several northern species reach their southern limits in the state, either in the highlands or as far down as Monmouth and Hunterdon counties. Some wide-spread species are absent from the pine-barrens, while various southern ones occur only there. The rarest New Jersey species are *Asplenium pinnatifidum* (or *trudelli*) and *Equisetum pratense,* the localities for both of which are now lost.

The geographical distribution of bryophytes and lichens was the principal topic which occupied the meeting of the Sullivant Moss Society. A. J. Grout reported the discovery on Long Island of several mosses characteristic of the southern coastal plain, whereas L. E. Anderson told of localized areas of northern bryophytes in North Carolina. W. C. Steere demonstrated that *Bryoxiphium norvegicum,* the "sword moss," on the basis of its present distribution, must be a preglacial and interglacial relic species.

The officers for 1937 will be: *President,* W. C. Steere; *vice-president,* Winona H. Welch; *secretary-treasurer,* R. A. Studhalter.

PROGRAMS RELATED TO BOTH ZOOLOGICAL AND BOTANICAL SCIENCES (F AND G)

(*Reports from A. M. Banta, Orlando Park, M. Demerec, Paul S. Welch, J. E. Ackert*)

The fifty-fourth annual meeting of the American Society of Naturalists featured its policy of attempting to correlate the different biological disciplines and to further the philosophy of biology. The Biologists' Smoker, arranged by the Naturalists in collaboration with seven other biological societies and the American Association for the Advancement of Science, was held on Tuesday evening. This is the one affair of convocation week which brings together all the biologists. This year's attendance, estimated at 800 to 1,000, greatly surpassed expectations and was a highly successful get-together.

The round-table discussion on "Genetics and Development," sponsored by the zoologists, geneticists and naturalists, taxed the capacity of the largest available room, seating 500, at the Municipal Auditorium.

The Naturalists symposium on Thursday afternoon brought together an audience of about 500. "Supra-specific Variations in Nature and in Classification" was discussed from the view-point of zoology by Alfred C. Kinsey, from the view-point of botany by Edgar Anderson, and from the view-point of paleontology by George Gaylord Simpson. The excellent papers by these three outstanding younger workers were followed by a brief discussion and summary by William K. Gregory. It is impossible to make an intelligible brief statement concerning these papers except to state that the audience was convinced that real progress is being made in obtaining substantial evidence concerning the origin of the higher categories of plants and animals. The interested biologist will find these papers in the *American Naturalist* for March–April, 1937.

The annual Naturalists' dinner held on Thursday evening was well attended and was highly successful in all respects. It was followed by the presidential address of C. E. Allen, who discussed "Haploid and Diploid Generations." In this very thoughtful and authoritative address the speaker went far toward the clearing up of the puzzling relationships between, and the origin of, the diploid and haploid generations.

The twenty-second annual meeting of the Ecological Society of America began with the Tuesday morning session, at which papers on plant ecology were presented. W. H. Horr gave a report upon the "Effect of Drought on Kansas Trees," and emphasized soil structure and composition as well as infestation of trees by wood borers as influences determining the survival of trees. Soil composition in relation to forest units in north central New York was also emphasized by V. A. Young, and C. H. Diebold presented a series of interesting interrelationships between soil characteristics, water table, soil temperature and snow cover at the Arnot Forest, New York. H. J. Costing discussed the place of the loblolly pine in succession in the Piedmont of North Carolina, and B. W. Wells discussed the "Origin of the Southern Appalachian Grass Balds," in which the view was presented that

these balds were probably initiated through local human interference and persist for centuries as an aberrant herbaceous climax.

The ecological program for Tuesday afternoon was in two sections. The first of these was a joint symposium with the American Society of Zoologists on the subject of experimental populations. The first of the invitational papers was on "Experimental Populations of Microscopic Organisms," by Willis H. Johnson, and this was followed by "Experimental Studies of Insect Populations," by Thomas Park. The third paper was given by A. M. Banta on "Population Density as Related to Sex and Evolution in Cladocera," and the final paper was presented by Raymond Pearl on "Biological Principles Affecting Human and Other Populations." The symposium was well attended, and it was felt that the speakers had presented a timely review of a difficult subject. The discussion of the papers at the close of the symposium was led by W. C. Allee, presiding officer of the session.

The second section on Tuesday afternoon was a joint session with the Society of American Foresters on the subject of "Regional Problems in Forest Soils." H. A. Lunt discussed "Forest Soil Problems in New England," and T. S. Coile discussed those soil problems pertaining to the Piedmont plateau. "The Importance of Surface Geology in Forest Soils" was emphasized by H. J. Lutz. Nitrogen deficiency in forest soils of New York was discussed by R. F. Chandler, in which the theory was proposed that certain hardwood species which have a high nitrogen content appear more frequently on poor sites because of the fact that they absorb nitrogen efficiently. "Soil Profiles and Hardwood Growth" was reviewed by J. T. Auten, and the "Interrelations of Forests and Soils in the Post-Climax Forest Communities of the Grassland Formation" was discussed by J. M. Aikman.

The annual dinner of the Ecological Society of America was held on Tuesday evening. At its close the vice-president, J. G. Needham, read the presidential address of W. S. Cooper. The address reviewed certain aspects of the growth of the Ecological Society and made certain suggestions for its future development. Dr. Cooper was unable to attend the Atlantic City meetings because of illness, and Dr. Needham expressed the gratitude of the society to Dr. Cooper for a most successful year. Following the presidential address, V. E. Shelford presented an interesting résumé of the origin and early development of the Ecological Society of America, and this was followed by moving pictures in natural color, presented by John A. Small, the local representative of the society, and entitled "Some Plants of the New Jersey Pine Barrens."

On Wednesday morning there was a general session for presentation of papers on "Animal Ecology." The first paper was by E. B. Powers and his associates upon "Carbon Dioxide as an Influence in Various Physiological Respiratory Responses in Fresh Water Fishes." This was followed by a report by V. D. Vladykov on the spawning and feeding habits of the haddock and the relation of these factors to commercial fishing activities. Four papers followed upon the general subject of activity. Orlando Park discussed the nocturnal activity of Panama rain forest animals and, secondly, discussed the activity of the cave crayfish, *Cambarus pellucidus.* This was followed by an analysis of the activity of another crayfish, *Cambarus virilis,* by T. W. Roberts, and W. J. Hamilton reported upon the "Activity, Home Range, and Homing Instinct of the Field Mouse." W. C. Allee presented a paper upon the effect of numbers on rate of cleavage in the eggs of the sea urchin, Arbacia, in which the rate of first cleavages was used as a measurement of physiological effects of population density, and it was shown that overcrowding retarded the rate of first cleavages. Bird and mammal communities in northern Illinois were discussed in a paper by W. C. Van Deventer. The session closed with a stimulating account of the "Ecology of the Forest Floor" by A. P. Jacot, in which the natural food of a species was stressed as of cardinal importance, and the lack of adequate information upon forest floor ecology was emphasized.

The general section of the Botanical Society of America met with the Ecological Society of America on Wednesday afternoon in a joint session. The initial paper was by T. K. Pavlychenko upon the "Root Systems of Certain Forage Crops in Relation to the Management of Agricultural Soils," and this report was correlated with the excellent demonstration of root systems placed on display by the author. The "Black Gum in New Hampshire" was the subject of a paper by H. I. Baldwin. F. C. Gates discussed "The Effect of Drought on Succession"; J. M. Aikman discussed the "Western Limits of Distribution of Important Species of Eastern Hardwoods," and R. F. Griggs discussed "Timberlines in the Northern Rocky Mountains." W. R. Chapline reported upon the importance of ecological methods in the restoration of the western range of the United States, and R. S. Campbell followed with the problems involved in measuring forage utilization on western ranges. The session closed with a paper by Waldo S. Glock, in which the age and season of growth of the western juniper of the Sierra Nevada were discussed.

Thursday morning was occupied by the final business meeting of the society. The following officers for 1937 were elected: R. E. Coker, *president;* H. de Forest, *vice-president;* Orlando Park, *secretary-treasurer.*

On Thursday afternoon a symposium was held with the American Society of Plant Physiologists and the Ecological Society of America on the subject of "Techniques." A number of important instruments and techniques of use to both physiologists and ecologists were discussed. H. L. Shirley reported upon the testing of drought resistance of tree seedlings, and R. H. Wallace upon "The Use of an Instrument for Recording Light and Temperature and Maintaining an Automatic Null." B. E. Brunstetter reported upon the "Spectograph," E. S. Miller on "Absorption Spectra of Alpha Carotene, Beta Carotene and Lycopene," and R. N. Jeffrey and G. O. Burr on "Hydrogen Ion Concentration in Relation to Metabolism of Aquatic Plants." B. E. Livingston and W. L. Norom reported upon the "Water-absorbing Power of the Soil as Related to Wilting," Hilda F. Rosene on "The Distribution of Water Intake in Excised Roots," and Philip R. White upon "Root Pressure Developed in Isolated Roots Growing in Vitro."

The Ecological Society's program closed with an all-day field trip to the Cape May Peninsula under the guidance of John A. Small.

The major portion of the program of the Genetics Society of America was devoted to demonstration papers. At three sessions 31 demonstrations were presented. The Tuesday morning session was occupied by botanical demonstrations, four of which dealt with Datura, three with maize and one each with Tradescantia, Nicotiana, Hemerocallis and Reseda. Among other things, the Datura group demonstrated the geographical distribution of certain chromosomal types, a striking effect of temperature and moisture on mutation rate in pollen and the assortment of chromosomes during microsporogenesis in triploids. H. B. Creighton presented evidence that a homozygous short deficiency in maize is responsible for a white seedling type and B. McClintock demonstrated on the same organism the effect of a homozygous deficiency appearing in mosaic patches. At the same session D. F. Jones showed the evidence for the occurrence of somatic segregation in maize. Two other demonstration sessions were devoted to zoological papers; the one on Wednesday afternoon being a joint session with the American Society of Zoologists. Ten out of the 20 papers presented dealt with Drosophila. At this year's meeting salivary chromosome work was represented by only one demonstration, *viz.*, that of M. E. Hoover showing that inversions do not have any significant influence on synapsis. Transplant work, however, was represented by two demonstrations. D. F. Poulson and M. Rabinowitz showed an interesting series of demonstrations covering certain stages of the development of Drosophila. J. W. Gowen and W. C. Price reported a similarity in the behavior of viruses and genes when treated with x-rays and ultraviolet rays. In addition to the demonstrations a joint discussion session on "Genetics and Development" was held with the American Society of Zoologists; and a joint round-table conference dealing with the development of resistant strains in animals and plants was held with the American Phytopathological Society. At the discussion session four short papers were presented, which were followed by a general discussion. The round-table conference was in charge of R. A. Emerson, who led the discussion after two short introductory papers given by J. W. Gowen and E. C. Stakman.

The Limnological Society of America held its second annual meeting on Wednesday forenoon and afternoon. The scientific program presented consisted of 20 papers. In addition, the program carried 14 papers read by title. The papers read dealt with various limnological investigations such as bacteria in Great Salt Lake, growth and temperature relations in certain Micro-Crustacea, lake succession, freshwater Medusae, algal floras, sea-run brook trout, modification of fish food production, limnology of the profundal benthic zone in Lake Michigan, energy budgets of an inland lake, lake sediments, light penetration in lake waters, oxygen in the thermocline, distribution of Protozoa, methods of rearing certain aquatic insects, and on the invertebrate fauna of a certain portion of the Hudson River. At the close of the scientific program the annual business meeting was held. The following officers were elected for 1937: *President,* J. G. Needham; *vice-president,* L. H. Tiffany; *elective member of the executive committee,* F. F. Fish.

The American Microscopical Society held its fifty-fifth annual meeting on Wednesday. The following officers were elected for 1937: *President,* W. W. Cort; *first vice-president,* O. E. Jennings; *second vice-president,* J. W. Scott; *secretary* (3 years), J. E. Ackert; *elective member of executive committee* (3 years), A. B. Dawson. Henry B. Ward, H. N. Lyon and William E. Dresher, who have served the society for fifty years, were elected to honorary membership. J. E. Ackert and A. M. Chickering were named to represent the society in the council of the American Association. The society voted to meet with the American Association for the Advancement of Science at Indianapolis in 1937.

SECTION ON ANTHROPOLOGY (H)

(*Report from Ralph Linton*)

This section held a meeting on December 30. Wilton M. Krogman submitted a report on racial types at Tepe Hissar, Iran, from the mid-fourth to the mid-second millennium B.C. Two distinct racial groups were present in the city throughout this period, one proto-Mediterranean, the other proto-

Nordic. The latter, whose members were in the minority, was probably intrusive from the steppes. The large series of skeletons provided opportunity for valuable conclusions as to the health and length of life of these ancient city dwellers, showing that urbanization exacted a heavy toll at this time. The average age of the Hissar II population was only 27.8 years and there were many evidences of pathological conditions. More than 25 per cent. of all adults showed arthritic bone changes at an average age of 30 years.

Thomas H. Evans presented a paper on metopism, showing that the occurrence of this abnormality is correlated with particular types of palate form, mandibular fossa and pterygoid base. These correlations suggest that new human types may originate through such morphological deviations.

Mrs. T. E. Evans showed the possible origin of the conventionalized form of the Egyptian scarab and of the beliefs connected with this object from the resemblance of the insect to the top of the human skull. John E. Wilson reported on a peculiar type of arrowhead found in a limited area in southern New Jersey. The cultural affiliations of this type have not yet been determined.

Nels C. Nelson gave the address of the retiring vice-president on "Pre-historic Archaeology, Past, Present and Future." He traced the development of this branch of anthropological study, stressing the recent development of adequate stratigraphic techniques and the important results obtained with them during the past few years. Progress in this science has been so rapid he concluded that, if it continues at the present rate, all the main problems of culture origins and interrelations will be solved within another century.

SECTION ON PSYCHOLOGY (I)

(Report from John A. McGeoch)

The sessions of the section were held from Monday to Wednesday. The large number of abstracts submitted made it necessary to hold two parallel sessions on both the morning and afternoon of Monday and Tuesday. The first session on Monday was devoted to papers on physiological psychology. David I. Macht reported a pharmacodynamic analysis of cobra venom which showed that the venom is not a local anesthetic for ascending and descending nerve fibers or for sensory nerve endings, but that it produces analgesia by acting on the higher cerebral centers. H. Jasper and M. Rheinberger presented a series of results from simultaneous records of the activity of four different brain regions of unanesthetized cats with both monopolar and bipolar methods of recording. All cortical regions are in a state of continuous activity, but the type of activity of a given region varies greatly from moment to moment. K. Goldstein concluded from a study of behavior changes in frontal lobe lesions in human subjects that the basic changes in performance are not functions of changes in any one field or in any one performance, but that they are changes in total behavior. Studies of intellective changes accompanying cerebral pathology, made by H. M. Hildreth, found different deterioration patterns for each pathological group and for the control. A. C. Cornsweet reported that during recovery from complete etherization rats display, under stimulation, behavior patterns which reappear in a progressive cephalocaudad order. Recurrent subcostal pain in children was found by I. N. Kugelmass to be alleviated by improved respiratory function and postural alignment. An analysis of the psychological measurements made on the ten members of the International High Altitude Expedition to Chile in 1935 and on Andean residents were presented by R. A. McFarland in a way to show that the various psychological functions are directly related to the velocities of certain chemical processes.

A parallel session on Monday morning was devoted primarily to social psychology. A study of a large number of psychological and educational characteristics of 70 communities of New York State was presented by J. B. Maller. H. H. Remmers reported that attitudes toward social issues may be considerably changed by application of the proper social stimulus materials; J. Zubin described an empirical scale for measuring militarism-pacifism; and H. Cantril described the comparative reactions of radio and face-to-face audiences. G. K. Bennett presented a coefficient of consistency by means of which it may be ascertained whether or not differences between series result from inherent unreliability of the samples or from some more fundamental factor. D. Wechsler presented a configurational theory of genius which accounts for the phenomenon in terms of a combination of superior ability and altered qualitative pattern.

Six papers on the psychology of learning were read at the first session on Monday afternoon. A. J. Mitrano reported an irradiation of inhibition which may be accounted for in terms of a gradient with reference to the consummatory response. In associative learning, knowledge of results for the series is of negligible influence compared to the immediate after-effects of the specific response, according to R. T. Rock, Jr. Knowledge of results for the series and for specific responses will summate, however. H. Ewert presented an operational analysis of learning curves in terms of speed and acceleration, which overcomes many of the statistical

difficulties presented by learning data. Results reported by W. S. Ray suggest that retroactive inhibition, retrograde amnesia and the loss of recent as contrasted with remote memories in certain psychoses are manifestations of a single underlying mechanism. A partial repetition by G. Hendrickson of an early experiment by Judd on transfer of training yielded results which in part confirmed and in part deviated from those of Judd and which suggest a change in interpretation of the theory of transfer by generalization; and L. P. Gardner described other transfer experiments involving the learning of cows and horses in a discrimination problem.

The second session on Monday afternoon, devoted to papers in abnormal psychology, was opened by a presentation of a composite portrait of children having low hypothyroid rates and a detailed case-study of the results of three years of medication, by Paul A. Witty. Studies by J. Q. Holsopple of a mirror drawing test for the examination of psychotic patients over a period of seven years yielded positive correlations between mirror drawing performance and several types of adjustmental difficulty. From a study of race, culture and mental abnormality, C. Landis concluded that, phenomenologically speaking, abnormal patterns of behavior and experience may usually be satisfactorily explained with reference to the cultural environment of the individual rather than to his racial heredity. H. Hoagland, D. E. Cameron and M. A. Rubin reported that alpha brain wave frequencies after insulin follow a curve that lags the blood sugar curve, thus supporting Hoagland's view that the frequencies are proportional to cortical metabolism. A new variability analysis of electroencephalograms was described which may serve as a measure of psychotic disintegration. E. I. Strongin and L. E. Hinsie found the parotid secretory rate for psychotic patients, both in the early and late stages of illness, to be higher than that of the average "normal" individual. Migraine need not, according to M. B. Jensen, be associated with neurotic symptoms. The correction and prevention of migraine is largely, if not entirely, a problem of proper habit formation. E. S. Cowles presented evidence for the view that chronic alcoholism results from an irritation of the meninges and an edema of the central nervous system.

The first session on Tuesday morning contained papers on general theory. E. Girden reported that isolated striate muscular responses may be conditioned following curarization, which has theoretical implications both for cortical functioning and for conditioning. G. R. Wendt presented evidence for the long-continued central maintenance of behavior once initiated and discussed the significance of this evidence for theories of learning and of motivation. From a study of sensory attributes, as shown by the form of the isochromatic contours, E. G. Boring concluded that one attribute is distinguished from another only by the law of its variation as it is dependent upon the stimulus and that the existence of an attribute implies both differentiation of the stimulus and systemic differentiation within the mechanism of response. H. S. Langfeld outlined a theory of esthetic experience in terms of the motor theory of consciousness in which the esthetic response is conditioned by motor set. A comprehensive theory for psychology was presented by J. A. Melrose, in which memory is regarded as the unique datum of psychology and the behavior cycle as its unit. O. L. Reiser sketched the passage of psychology from its Galilean-Newton stage to its present relativistic stage of thinking and outlined the changed character of its problem.

At the other session on Tuesday morning, seven papers on physiological and comparative psychology were presented. A harmful effect of avitaminosis B_1 on maze performance without alteration of the per cent. of water in the brain or the microscopic appearance of the brain was reported by H. Stevens. Although tobacco smoke reduces the growth processes of white rats, L. A. Pechstein found that mild fuming speeds learning. Excessive treatment, however, inhibits learning. From a comparison of the maze learning of ferrets and rats, W. R. Miles concluded that the law of effect operates in only a restricted manner for the ferrets in the maze. A. Gesell presented evidence, both cinematic and tabular, upon detailed twin resemblances in behavior patterning and other characteristics which indicate deep-seated mechanisms of growth regulation which early determine many features of individuality. A. G. Bills concluded that mentally fatigued subjects suffer from a depletion of available oxygen and that this depletion is one important element in mental fatigue. A. S. Edwards described the results of 18 tests carried on through a period of 100 hours without sleep; and A. F. Blakeslee, T. N. Salmon and M. C. Hrubetz reported that, by their measures, taste acuity varies over a limited range during a period as long as three years.

In the second program devoted to papers on sensation and psychophysics, M. G. Preston reported that subjects not only avoid the repetition of judgments but also tend to give them in such a way as to overvalue the usual negative time error; and Irwin and Preston went on to show that the avoidance of repetition results from function at higher than perceptual levels. K. M. Dallenbach found the limens of temperatures for burning heat at different skin surfaces to lie between 46° and 51° C. A study of the functional relation between the magnitude of

cochlear response and intensity of stimulation, made by E. McCrady, Jr., E. G. Wever and C. W. Bray, demonstrated a general similarity of form for opossums between ages 59 and 82 days. The relation can be expressed as a power function with an exponent which does not depart greatly from unity. S. S. Stevens established numerical scales for the measurement of pitch and loudness and found that the subjective scale for pitch corresponds neither to the frequency scale of the physicist nor to the musical scale of the musician. The subjective scale for loudness departs widely from the ordinary decibel scale. Certainty in judgment, as J. Volkmann found, decreases in the vicinity of the category-threshold and alternative judgments occur in the same vicinity. S. B. Cummings, Jr., found a consistent diminution of vibratory sensitivity with cutaneous hypesthesia, which implies that both superficial and deep mechanical receptors are capable of giving rise to the vibratory sensation.

The papers of the second session on Tuesday afternoon were mainly upon the phenomena of affection and emotion. Work upon cardiac acceleration in emotional situations, by J. G. Beebe-Center and S. S. Stevens, yielded evidence that sudden cardiac responses in cats to emotional stimuli must be due to activity of the para-sympathetic system. Analysis by W. A. Hunt of moving pictures of the startle pattern in 60 infants, aged 8 days to 18 months, revealed a large number of incidental fear responses which are usually overlooked when observation unaided by motion pictures is employed. Examination by F. M. Clark of similar cinematic records revealed a wealth of plantar responses to an auditory stimulus. C. A. Ruckmick presented an experimental and a theoretical critique of the problem of detecting deceitful oral responses; E. J. Barnes reported no major effects upon mental work from constant musical distraction; and D. P. Boder and E. V. Beach described data upon the wants of adolescents, which suggested a method of discovering the social integration and social maturity of the individual.

The usual custom of a joint dinner with the Section on Education was continued this year. The dinner was held on Tuesday evening and was followed by the addresses of the retiring vice-presidents of the two sections. (See report of Section on Education).

One of the major features of this year's program was a symposium on "The Cortex and Behavior," arranged by and held under the chairmanship of L. Carmichael, and participated in by both physiologists and psychologists. In a paper on "Recovery of Function and the Problem of Functional Localization in the Cortex," J. G. Dusser de Barenne presented new facts concerning the functional organization of the sensorimotor cortex and the visual cortex in relation to the thalamus, as determined by electrical recording and application of his local strychninization technique. R. L. De No spoke on "Intracortical Connections and Connections of the Cortex and Thalamus." Physiological conclusions were offered by him, based upon his remarkable histological studies. New evidence was given for neuron circuits in the brain. K. S. Lashley, in a paper on "The Interplay of Cortex and Thalamus in Sensory Functions," reported new evidence showing that the subcortical visual mechanism is even more important in mediating behavior than had been indicated in his previous studies. P. Bard presented a study on "Representation in the Cortex of Tactile and Proprioceptive Sensibility," reporting experiments which made possible the differentiation of the cortical areas involved in these two important receptor fields.

The single session on Wednesday morning was devoted to papers primarily on individual differences. H. Brandt described a logical decision test; R. S. Uhrbrock analyzed studies of the appearance of left-handedness; A. R. Lauer analyzed sex and age differences in a group of psychophysical traits; H. C. Lehman and D. W. Ingerham reported certain relations between chronological age and musical productivity; C. Patrick studied the processes of creative thought in groups of artists and non-artists; A. L. Benton reported no significant differences between more and less motivated subjects on a group intelligence test; and H. C. Hansen compared the scores of Indian pupils on verbal and non-verbal intelligence tests with results which showed that the Indian gains higher scores on the non-verbal than on the verbal tests.

SECTION ON SOCIAL AND ECONOMIC SCIENCES (K)

(*Report from James Ford*)

The first session was held jointly with the Section on Historical and Philological Sciences. Watson Davis, of Science Service, dealt with the history of science and the press and in the lengthy discussion which followed explained microphotography and its uses in the reproduction of rare historical documents or in making modern scientific researches available in cases in which no publisher can be found.

Joseph Mayer, secretary of the Section on Historical and Philological Sciences and consultant at the Library of Congress, presented a scholarly paper on medievalism in its relation to scientific advance and modern business, which showed "the conditioning rôle of medieval economic institutions" and how they rendered Adam Smith's theoretical assumptions unreal.

The Thursday morning session was opened by Marshall E. Jones, of the Massachusetts Department of

Public Welfare, with a paper on social work method in which current methods of placing children in foster homes were closely analyzed and one hundred selected case histories examined. Greater flexibility in the discovery and adaptation of home and community resources to the needs of individual children was shown to be necessary. Charles P. Sheldon, of Albany Medical College, dealt with the problem of marriage among persons with premature arrests of psychic development.

The address of the retiring vice-president, Shelby Harrison, director of the Russell Sage Foundation, entitled "Winning Social Advance through the Process of Accretion," showed the importance of coordinated research, leadership and organization. Joseph Mayer's paper on the medieval just price which followed revealed it to be a device for the maintenance of *status quo, and "natural justice" was made synonymous with* feudal stratification. A full hour of general discussion brought out the bearing of early practices and tradition upon contemporary economic and social policies.

SECTION ON HISTORICAL AND PHILOLOGICAL SCIENCES (L)

(*Report from Joseph Mayer and Sylvia Mostow*)

The Section on Historical and Philological Sciences met on Tuesday and Wednesday. Although the numbers in attendance were small, the interest was keen and the discussion excellent.

The first session, on Tuesday morning, was held jointly with the Section on Social and Economic Sciences, with James Ford, of Harvard University, presiding. Two papers were presented. The first paper, by Watson Davis, director of Science Service, took up the history of science and the press. Particular emphasis was laid upon what he called "dark areas" of science. These included the following: distortion or suppression of genetics prompted by nationalistic or racial bias; failure to use psychological testing techniques as an aid to the unemployed; superstition and lack of scientific methods of thought and action in everyday life; the hush-hush attitude, such as has been prevalent toward venereal disease; our failure to preserve peace by proper distribution and constructive utilization of human and natural resources. The second paper by Joseph Mayer, consultant in sociology at the Library of Congress, outlined the development of the modern business economy out of medievalism as a result of scientific advance. The effects of invention, geographical exploration and of machine technique upon the market and price system were emphasized. The chief economic issue in the transition continued to be one of what dominant class was to secure the greatest share of medieval "spoils" or modern "surplus," although the price revolution, arising from the influx of gold and silver from the New World, greatly affected estate holdings, colonization, export trade, ship building and money lending. In considering changes in economic thought and policy that had taken place during the period, Dr. Mayer showed the continuance of the scholastic process of rationalizing the *status quo,* from the medieval "just price" and renascent mercantilism, through the doctrine of *laissez faire,* which rose to favor, despite obvious shortcomings, because it accorded with the aims of growing business and enabled merchants and industrialists to consolidate their control over a medieval tribute-rendering economic system.

At the second session on Tuesday afternoon two additional papers were presented. Shio Sakanishi traced in most interesting fashion the history of calendar-making in Japan and showed the intermixture of astrology and science in early efforts to establish a usable calendar. Between the years 696 to 1684 the government adopted the calendars used in China without any modification. In 1685 Shunkai Shibukawa, head astronomer of the Shogunate, worked out an improved calendar, incorporating all the new observations and original calculations which Japanese scholars learned from Dutch and other western sources. After a few more reforms, the Gregorian calendar was finally adopted in 1873, and for the first time the Japanese calendar rid itself of the strong influence of astrology and divination. The next paper, by Jekuthiel Ginsburg, of Yeshiva and Columbia Universities, traced the history of efforts by modern mathematicians to find a clue to the methods employed by Archimedes and the Hindus in approximating to $\sqrt{3}$, a problem which has baffled many historians. Attempted answers to this problem may be found in various periodicals, old and new. Dr. Ginsburg put forth the interesting suggestion that by assuming a crude method for striking averages—one that is considered too crude for modern use—many of these ancient approximations can be explained.

The third session, late the same afternoon, was given over to a symposium, under the leadership of Louis T. More, of the University of Cincinnati, on methods of teaching the history and philosophy of science. Dr. More outlined his method of teaching the subject, and this was followed by an animated and helpful discussion.

At the session on Thursday morning four papers were presented. The first, by Dr. More, traced the influence of the life and work of Robert Boyle, contrasting it with that of Isaac Newton. Dr. More likened the science of physics and chemistry to a complete sentence if taken together but incomplete if taken separately, chemistry serving as the subject and physics as the predicate, one static and the other dynamic. Boyle was designated as the father of chem-

istry. Dr. Karpinski in the second paper traced the history of mathematical publications in the United States up to 1850, most of the thousand or so books and the 3,000 editions covering elementary subjects. It was pointed out that nothing more could be expected in a new country without a great corpus of mathematical writings such as the old world had developed in the course of centuries. Referring to works in many languages, Dr. Karpinski cited Spanish works beginning with 1556 A.D. in Mexico and South America, a Dutch publication of 1730, early French works in Canada and New Orleans, German publications in Pennsylvania and one Choctaw arithmetic. The paper by Raymond J. Seeger, of George Washington University, dealt with Benjamin Franklin as a physicist and emphasized neglected elements in the work of that great American experimenter and speculator in physical science. Franklin's simple devices, broad interests and purposeful outlook showed him to be an ingenious experimenter and brought out his pioneering approach; his simple theories covering many phenomena, although most of them have now been superseded, showed him to be an ingenious speculator. Great stimulation to scientific activity resulted from the circulation of Franklin's hypotheses and caused him to be rightly called the first great scientist of America. The paper by J. W. Morgan, of Wittenberg College, described the state of science 130 years ago. It outlined the history of several of the most important scientific conceptions and theories during the early transition period from medieval to modern times, using as a primary source for the period studied an early abstract journal published in London from 1805 to 1815. Particular attention was given to Lavoisier, who freed chemistry from the restrictions of the phlogiston theory; to the continuance of phlogistic terms as late as 1810; to the beginnings of the atomic theory of Dalton; to Davy's brilliant electrochemical researches, which resulted in the discovery of potassium and sodium; and to the establishment of the "element" as basic for chemical advance.

The concluding session was held on Thursday afternoon with Dr. Seeger leading the discussion, which centered upon a paper by Philip Shorr on the progress of the history of medicine to the eighteenth century with particular reference to the "History of Physick" by Sir John Friend. Criticizing this history as no better than others of its time, Dr. Shorr cited as particular faults an over-emphasis on the contributions of the Greeks and the neglect of certain very important phases of medicine. As against eighteenth century practice, modern medicine, with its close relation to biological advance, stands in marked and instructive contrast.

Section on Engineering (M)

Subsection on Aeronautics

(Report from Lester D. Gardner)

The aeronautical meeting was held on Tuesday. T. P. Wright discussed "Speed and Airplane Possibilities." As a basis for his technical presentation he thought that the two fundamental concepts which weave themselves into all human relationships are space and time. The desire to decrease the effective size of the world by the conquest of space and the desire to increase the effective span of life by the saving of time can be found as primary motives in a very great number of human activities. It is interesting to note that a simple relationship of these two concepts expresses the physical phenomenon velocity or speed, thus, $D/T = V$. The improvement of speed of transportation, whether involving the sending of ideas and words or transporting things and persons, has been fundamental in the advancement of civilization. We thus find evolved in the former case the basic development of the telegraph and telephone and radio, and in the latter, of the wheel, the sailboat and steamboat, the steam and electric locomotive, the automobile, the airship and airplane. It has been said quite truly that "the very pace of life depends upon the speed with which matter can be changed into energy available for transportation. The airplane, which is our latest method of transportation of goods and persons, has already demonstrated its superiority in the matter of speed. Speed is the *raison d'être* of aviation."

When a chart is made, plotting speed against time, the rapid advancement of air transport, as well as other forms of aviation during the past six years, immediately becomes apparent. The present average speed of transport planes is 200 m.p.h.; for racing landplanes 352 m.p.h.; and for racing seaplanes 441 m.p.h. It is believed that these speeds will be increased within the next ten years so that the cruising speed of air transports will be 300 m.p.h., and the record for landplanes 425 m.p.h., and for seaplanes 500 m.p.h. To demonstrate these claims Mr. Wright presented calculations and charts which supported his contentions.

Igor I. Sikorsky, in describing "The Future of Transoceanic Air Transportation," said that he believed that during the coming five years it will become possible to reach Europe within about twenty hours of flying on board a luxurious air transport with comfortable staterooms, a dining saloon, smoking lounge, etc. The greatest difficulty to overcome is the considerable range required. To make Atlantic flying really successful, it is necessary to produce aircraft capable of actually covering a distance of about 3,500 miles plus a margin of at least another 1,000 miles.

To make such a service practical, it is further necessary that the aircraft carry, besides crew, about 10 per cent. of its gross weight in payload and another 10 per cent. in various equipment, such as seats, berths, dining accommodations, food, water, soundproofing, etc. The creation of an aircraft capable of fulfilling these requirements was impossible only a few years ago. It became possible at the present time as a result of various achievements in the line of aeronautical science, construction and methods of operation. It appears that the ship must be substantially larger in size than the average modern air transport. It is believed that 40 or 50 tons would prove to be the smallest practical size that would permit combining the long range with the lifting capacity and satisfactory accommodations on board to carry 40 or 50 passengers across the ocean.

At the beginning we may expect a cruising speed of about 160 m.p.h. Within ten years an operating speed of 200 to 250 m.p.h. appears probable. Furthermore, we can expect that after the establishment of transoceanic air lines, the next step would be to equip the aircraft with arrangements for high altitude flying which will permit operation at 20,000 to 25,000 feet altitude. At this height, it would become possible to increase still further the cruising speed, and, what is even more important, to fly always in a zone of excellent clear weather, above all major atmospheric disturbances. Within a few years to come, we can expect to have this final and most interesting step in the development of air travel. Our world will become smaller, it will become possible to travel across the Atlantic within about twenty hours, reach any point of the globe within two or three days flying and make excursions over the north pole. In line with this development, we can expect a further and most interesting expansion of the aircraft industry and science.

Major General Benjamin D. Foulois, former chief of the Air Corps, U. S. A., took part in the discussion which followed the presentation of the papers.

SECTION ON MEDICAL SCIENCES (N)

(*Reports from Vincent du Vigneaud, Thomas J. Hill, John C. Krantz, Jr.*)

The meetings of the Section on Medical Sciences were devoted to a symposium on cancer, with the exception of a joint session with the Subsection on Pharmacy and a session on viruses, the virus session being held in Philadelphia. The meetings of the symposium were unusually well attended and represented a high point in attendance at meetings of the Section on Medical Sciences. The discussions elicited by the papers were very lively and much worth while.

The symposium was divided into a number of sessions, each taking up some fundamental aspect of the cancer problem. The Tuesday morning session was given over to a consideration of radiation, particularly the newer work involving high voltage radiation, while at the afternoon session heredity and constitutional factors were considered. All day Wednesday was devoted to a series of papers on the induction, stimulation and inhibition of tumorous growths, while on Thursday morning tissue culture and metabolism of cancerous tissue were the topics around which the papers centered. In addition, two general sessions on cancer were held before the entire association. The first general lecture was given on Thursday afternoon by C. C. Little, of the Roscoe B. Jackson Memorial Laboratory. In this lecture the social significance of cancer was evaluated. The second general lecture was given on Friday afternoon by Dr. Walter Schiller, of Vienna, on the changes and modifications in the conception of carcinoma.

The symposium on cancer was so arranged through the cooperation of the Section on Physics and the American Physical Society that the radiation portion of the cancer symposium followed the symposium of the physical group on "Radiological Physics," which was given on Monday morning and afternoon. To serve as a transition between the two programs and to introduce to the medical sciences section the recent developments in radiological physics that may have some application to biological problems, particularly to cancer, Merle A. Tuve, of the Carnegie Institution of Washington, discussed the artificial sources of high voltage radiations and their applications. In this discussion Dr. Tuve warned the biological sciences that in some respects the modern physics was no longer the exact science that the classical physics was and care must be taken in carrying over too quickly certain findings in the recent developments of high voltage radiation. The use of radioactive substances as indicators in biological work was also emphasized. The methods of measuring x-rays were then discussed by L. S. Taylor, of the National Bureau of Standards, a question which is vital to biological investigations as well as those of more purely physical nature. In considering the biological action of ionizing radiations, G. Failla, of the Memorial Hospital, presented a new theory correlating many apparently unconnected facts that have been observed. The theory was based on the hypothesis that the radiations in addition to producing ordinary ionization brought about reactions in which small ionizable molecules were formed out of large molecules, thus causing water to enter the cell. This would explain the swelling of certain cells in radiated tissue and would also explain the erythema action of soft x-rays. Other implications of the theory were also discussed. The comparative effect of neutrons and x-rays on normal and neoplastic tissue was then

considered by J. H. Lawrence, of Yale University. The cyclotron developed by E. O. Lawrence, which gives an intense source of neutrons, was used for the biological investigations. The effect of x-rays and neutrons was compared on white mice for their ability to produce leucopenia and for their lethal action. Dr. Lawrence emphasized that workers in laboratories producing neutrons must safeguard their health by avoiding unnecessary exposure to neutrons. Frequent blood counts and physical check-ups should be insisted upon. R. E. Zirkle, of the University of Pennsylvania, then took up the biological effect of alpha particles and their relation to the effects of neutrons. In this paper and the preceding one the belief was expressed that the neutrons were more effective for some kinds of cells than for others in comparison with x-rays. Neutrons are therefore being intensively studied as possible therapeutic agents. Alpha particles because of their low penetration can not be used in therapy but will serve as a valuable auxiliary tool in quantitative studies of the biological action of the neutron because of the similarity of their ionization tracks. That the combination of artificially produced fever with Roentgen-radiation seemed to be more effective than radiation alone in the treatment of various types of cancer was brought out in a paper by Stafford L. Warren and John Jares, of the University of Rochester. The session was brought to a close by a discussion of the recent progress in the study of radium poisoning by R. D. Evans, of the Massachusetts Institute of Technology. The development and use of very sensitive detectors of gamma radiation were described which permit quantitative observations on patients containing less than one millionth of a gram of radium. The measurement of radon from the breath of patients of radium poisoning was also related. Suspected cases of radium poisoning can now be tested and treatment instituted before fatal symptoms develop.

The session on heredity and constitutional factors was opened by Maude Slye, of the University of Chicago, who presented a theory for the genetics of malignancy and the localization of malignancy. Briefly the theory postulated, first, malignancy as a localized recessive character, each type of malignancy being a unit character capable of suppression by a dominant, and second, localization factors of such a nature that they provide the occasion for malignancy where they occur in tissues capable of malignancy, and when the necessary interrelation with an external causative factor arises. That some influence was transmitted directly from a female mouse to her female descendants was emphasized by C. C. Little, of the Roscoe B. Jackson Memorial Laboratory, as being of prime importance in determining whether they will have cancer of the breast. A new type of either transmission or inheritance, which is not Mendelian, was thus claimed to be demonstrated for the first time. The principle may be far reaching in application. C. J. Lynch, of the Rockefeller Institute for Medical Research, then presented her fundamental work on the inheritance of susceptibility to lung tumors in mice. The respective rôles of heredity and somatic mutation in the etiology of tumors inducted by parasites and chemical irritants was next considered by W. F. Dunning and M. R. Curtis and F. D. Bullock, of the Institute of Cancer Research. It was concluded from their studies of tumor incidence in rats infested with Cysticercus larvae and in animals treated with benzpyrene and dibenzanthracene that genetics plays no part in the tumor incidence and that the genetic constitution of any cell can be overcome by the irritant action of carcinogenic agents. The relationship between the histology of spontaneous mouse tumors and the genetic constitution of the animals in which they arise was presented by A. M. Cloudman, of the Roscoe B. Jackson Memorial Laboratory. The genetics of mouse leukemia was then discussed by E. C. MacDowell, of the Carnegie Institution of Washington. It was brought out that the extrinsic factors make the determination of the genetic formula very difficult, but the genetic control of the intrinsic factors, even though they are unidentified, opens the way, especially in his first hybrid generation, for the identification of the effective extrinsic factors. Such control may have immediate medical application. The final paper on the program was by Felix Bernstein, of New York University, on the factors of heredity, age and acquired hypersensitiveness.

The session on induction, stimulation and inhibition of tumorous growths was opened by L. F. Fieser, of Harvard University, with a discussion of the organic chemical aspects of cancer work. In this discussion he presented the chemistry of the carcinogenic hydrocarbons and indicated the possible relations between structure and carcinogenic action that have been brought out by recent synthetic work. Apparently the five-membered ring in cholanthrene was shown to be unnecessary, but the work indicated that the presence of a methyl group at position 10 was extremely important, whereas it did not seem necessary for position 5 to be substituted. The structural relations were also brought out between the carcinogenic compounds and the sex hormones. The production of tumors by chemical agents was next discussed by F. C. Wood, of the Institute of Cancer Research, who emphasized that a given carcinogenic compound can produce very different and varied types of neoplasms. Studies pertaining to the appearance of lung tumors in mice injected with dibenzanthracene were related by H. B. Andervont, of the United States Public Health Service.

The work brought out that the injection of dibenzanthracene could induce tumors in organs distant from the site of the injection. By using strains which developed spontaneous tumors of the lungs and those that did not it was shown that the difference in susceptibility of various strains of mice to induce pulmonary tumors may be a matter of degree only. The influence of estrogenic chemicals upon the stimulation of atypical growths was then discussed by W. U. Gardner, of Yale University. The pathogenesis of the malignant tumors of the testis was next considered by R. S. Ferguson, of the Memorial Hospital. He indicated that such tumors are the result of neoplastic growth of the germ cell, and concluded that any germ cell, extratesticular, in the rete testis, in the normal tubule, may give rise at any stage in its life history to the most complex or simple exhibition of neoplastic teratoid growth. C. F. Geschickter, of Johns Hopkins Hospital, then took up the question of the relation of oestrin and other hormones to tumor formation in the breast. It was suggested that endocrine researches have added more to our understanding of benign tumors and conditions previously confused with early cancer than to an understanding of cancer itself. In the formation of true neoplasms apparently inherent variations in tissue susceptibility involving hereditary factors are predominant and endocrine stimulation merely sets the clock forward or backward, inducing or preventing the manifestations of such inherent qualities in the tissue.

The afternoon session on the same series of topics was opened by H. J. Bagg, of the Memorial Hospital, with a consideration of the factors involved in the experimental production of teratoma testis in the fowl. He was able to show that zinc chloride injections produced teratoma testis only when given in the spring of the year but that when potent gonad-stimulating extracts of the anterior pituitary were injected the chemical could produce the teratoma as late as the end of August. The hormone preparation itself did not produce teratoma testis. In a paper on the stimulation and inhibition of tumor growth by J. B. Murphy, of the Rockefeller Institute for Medical Research, the suggestion was made that malignancy is a result of a break in the hypothetical balancing mechanism of the cell, which consists of a stimulating and retarding factor. Work on the inhibiting substance obtainable from extracts of fowl tumors which is capable of neutralizing the filtrable causative agent was presented. A similar inhibiting substance has now been found in normal tissue, principally placenta, embryo skins and prelactating mammary glands. In the case of the latter it has been possible to get both a stimulating preparation as well. The chemical properties of the transmissible agent in the Rous chicken sarcoma No. 1 was next taken up in a paper by J. W. Jobling, E. E. Sproul and Sue Stevens, of Columbia University. These investigators were able to extract the active principle by several fat solvents from the tumor tissue. The active principle appears to be very unstable and is particularly sensitive to oxidation. The lipid extract will not produce tumors alone, but a suspension in a saline extract of normal tissue is active. It was also found that apparently it is the protein in the extract of normal tissue which is active, since casein was also found effective. The tumors produced are histologically identical with the usual Rous sarcoma and are malignant, as attested by metastases. Experiments with carcinoma in frogs was described by B. Lucké, of the University of Pennsylvania. The probable etiologic relationship of a virus to this carcinoma was indicated. The session was concluded with a statistical analysis of the mortality from cancer by L. I. Dublin, of the Metropolitan Life Insurance Company. It was shown that 150,000 deaths from cancer will occur this year and cancer ranks second to heart disease. The rise in cancer mortality is practically limited to males and, among white men, increases in the recorded death rates were sizable only at ages above 55 years. Among white females such increase as appears has occurred at the ages above 65 years; in the broad age period 35 to 54 the trend of the death rate in this group was significantly downward.

The final session devoted to the metabolism of cancerous tissues was opened by W. H. Lewis, of the Carnegie Institution of Washington, who presented his recent work on the cultivation and cytology of cancer cells, motion pictures being utilized to bring out many of the very striking points. Dr. Lewis inclined to the belief that malignancy is due to some chemical change in the protoplasm and not to chromosomal or gene alteration. The biochemical significance of the Pasteur-Meyerhof reaction in intermediate carbohydrate metabolism and in particular that of cancer tissue was discussed by D. Burk, of the United States Department of Agriculture. The various explanations of the reaction by Pasteur, by Meyerhof and the more recent explanations by Lipmann and by Kluyver were discussed and the free and heat energy relations of main over-all reactions were interpreted. All malignant tissues, regardless of host, tissue or cause, shows an insufficiency of the Pasteur-Meyerhof reaction, that is, an insufficient rate of respiration in eliminating aerobic lactic acid fermentation. The relation of protein metabolism to malignant growth was then taken up by C. Voegtlin, of the National Institute of Health. The recent work of Dr. Voegtlin, with J. M. Johnson, M. E. Maver and J. W. Thompson, on the growth of tumors in hosts maintained on diets deficient in certain essential amino acids was discussed. It was shown that an adequate supply of lysine, tryptophane and cystine was essential

for the proliferation of spontaneous mouse sarcoma. When the diet was deficient in cystine and the growth of the carcinoma inhibited, glutathione could bring about resumption of the tumor growth, even as it does body growth under these conditions. Evidence was also presented that the lytic and synthetic activity of cathepsin is regulated by the oxygen tension, pH and apparent oxidation-reduction potential of the system. The rôle of the amino acids and nucleic acid derivatives in developmental growth and their possible significance to the cancer problem was next considered in a paper by F. S. Hammett, of the Lankenau Hospital Research Institute. The session was brought to a close by G. H. Scott, of Washington University, who discussed the distribution of inorganic salts in adult and embryonic cells and tissues, with special reference to cancerous tissues.

The session on viruses held at Philadelphia in the hall of the Philosophical Society was opened by a paper by W. M. Stanley, of the Rockefeller Institute for Animal and Plant Pathology, in which was presented his important and fundamental work on the crystallization and chemical studies of the tobacco-mosaic virus proteins. This was followed by a presentation by R. W. G. Wyckoff, of the Rockefeller Institute, of the ultra-centrifugal concentration of viruses and other biologically active proteins. S. Mudd, of the University of Pennsylvania, then presented his recent studies on labile bacterial antigens and described the methods of their preparation and preservation. The fact that a filtrable virus was involved in many upper respiratory infections was discussed by Y. Kneeland, of Columbia University. The session on viruses was brought to a close by G. P. Berry, of the University of Rochester, who presented his interesting work on the transformation of the virus of rabbit fibroma (Shope) into that of infectious myxomatosis (Sanarelli).

The Subsection on Dentistry held its meeting on December 28. Of the 16 papers presented, 14 were devoted to the biological aspect of dental science. The meeting was under the direction of the American Division of the International Association of Dental Research with the cooperation of the American Dental Association, the American Association of Dental Schools and the American College of Dentists.

Some interesting features of the program included the discussion of the purposes of the Institute of Clinical Oral Pathology by Theodor Blum. Two papers from the institute were presented, one by Raymond Gettinger on the development of the dental pulp and its relation to pathological change, the other by Theodore Kaletsky on the dependability of electric currents in testing retrogressive changes within tooth pulps. The results of a study of some of the properties of colloidal impression materials were presented by E. W. Skinner and W. R. Kern. An equation expressing the relationship between the time and temperature of vulcanization of dental rubber was presented by P. B. Taylor, Frank Hovorka and James Mohler. Lawrence Baker presented a paper showing by vital staining the manner of bone development following induced functional changes. M. W. McCrea presented a histological study of dental granuloma emphasizing the regularity of the presence of epithelium in either its resting or proliferated stages. A histological study of ameloblastomata given by Hamilton Robinson stressed the necessity of dentin as an active agent in the deposition of enamel and the impossibility of enamel being formed without this precursory substance.

The group from Yale University, consisting of L. W. Burket, Henry Miller, Casper Burn and David Weisberger, contributed a series of papers on the relation of infection to systemic disease. These papers recited the bacteriological findings in teeth from necropsies, the experimental production of tooth infection in monkeys and its relation to systemic disease and the effect of *streptococcus viridans* in the teeth of normal rabbits as compared to rabbits sensitized to this organism.

An incineration method for the determination of the ash content of the tooth follicle during odontogenesis was presented by H. R. Churchill. Maxwell Karshan gave the results of a lengthy chemical study of salivas of caries-resistant and caries-susceptible people. He indicated that the calcium content is the most likely salivary factor present. Women under treatment with the hormones estrone and gonadotropic hormone follutein were shown to have disturbances of the gums and oral mucosa by D. E. Ziskin. L. I. Grossman and B. M. Brickman showed that the pH of nocturnal saliva is definitely lower than that of diurnal saliva. A case report of carcinoma of the tongue as a sequel to leukoplakia was read by Malcolm Carr. B. I. Comroe discussed the diagnostic importance of the tongue in internal medicine, pointing out the many diseases which have oral manifestations. The last paper of this interesting meeting was given by Leon H. Collins, who discussed the nasal accessory sinuses and their diagnostic importance to dental practice.

The Subsection on Pharmacy held two sessions; one on Monday morning and the other on Monday afternoon, which was held jointly with the Section on Medical Sciences. The morning session was opened by a paper by Marvin R. Thompson, of the University of Maryland, on the assay of digitalis preparations. It was demonstrated that the International Reference Standard Digitalis powder gives rise to variable preparations compared with it in Great Britain, United States and Canada, where the methods set forth for extracting the standard are different. A

recommendation was made for the unification of these methods. Arthur Osol, of the Philadelphia College of Pharmacy and Science, presented a conductivity method for the determination of traces of chlorides in the presence of other ions. C. Jelleff Carr, of the University of Maryland, discussed the metabolism of the adrenalectomized rat. In general, it was shown that during the survival period after adrenalectomy, the metabolism diminished 25 per cent. without accompanying disturbance of carbohydrate metabolism. A paper presented by J. C. Forbes, of the Medical College of Virginia, discussed the isolation of a crystalline purine base from liver which protected rats against carbon tetrachloride and chloroform cirrhosis. Alfred Barol, of Philadelphia, set forth certain cardinal features in the selection of medicaments for the neutralization of excessive gastric acidity. The amphoteric hydroxide of aluminum was considered best suited for this purpose. The methods employed for the detection of the *cannabis sativa* and its preparations were reviewed by James C. Munch, of Temple University. The presence of chlorophyll interferes with the characteristic reactions for cannabinol, the generally accepted active principle of cannabis. Frances Beck, of the University of Maryland, presented studies on the effects of the anhydrides of many of the sugar alcohols on the dissociation constant of boric acid. Arno Viehoever, of the Philadelphia College of Pharmacy and Science, discussed experiments on the feeding of the berries of the matrimony vine to rats. The nutritious value of these berries was comparable to that of tomatoes in the rat's diet.

The joint session in the afternoon was opened with a paper on drugs affecting the autonomic nervous system by Theodore Koppanyi, of Georgetown University. Among other important observations it was shown that physostigmine stands out as the drug capable of inhibiting an esterase in the blood responsible for the continuous destruction of acetylcholine. Maurice Feldman, of the University of Maryland, presented a contribution to the etiology of gallstones, in which he showed that the pH of the bile of various species was a salient etiologic factor in the dissolution and formation of gallstones. The effect of posture on the alveolar carbon dioxide tension in man was discussed by R. J. Main, of the Medical College of Virginia. He showed that standing produced a drop in alveolar carbon dioxide and a mild alkalemia, which perhaps is indicative that man has not yet completely adapted himself to his upright posture. T. B. Magath, of the Mayo Clinic, presented a study of the incidence of Echinococcus disease in the United States and Canada. The incidence was highest in centers of immigration. Of interest was the fact that, although dogs in many foreign countries are infested with the echinococcus, particularly in Iceland, the dogs in North America are very rarely infested. The pharmacology of the drugs that affect the autonomic nervous system was reviewed by Abraham Myerson, of the Palmer Memorial Hospital, and, experimenting with human subjects, he confirmed many of the well-known actions of the autonomic drugs observed on animals. Joseph L. Svirbely, of the Carnegie Institute of Technology, presented studies on the effect of selenium dioxide on the vitamin C content of the organs of the rat. The selenium compound produced a marked decrease in the liver content of vitamin C; this action of selenium dioxide is antagonized by glutathione. Sensitivity to radiation of chromosomes was presented by A. Marshak, of Palmer Memorial Hospital. The chromosomes of the mouse, bean and pea show abnormalities upon radiation with the inhibition of mitosis. A detailed study of a toxicological nature of chronic arsenical poisoning from well water was presented by J. Wyllie, of Queen's University. The symptoms, origin and geologic aspects of the case were presented.

SECTION ON AGRICULTURE (O)

(*Reports from M. F. Morgan, H. B. Tukey, William H. Martin*)

A joint session was arranged with the northwestern section of the American Society of Agronomy. The program was opened by the address of the retiring chairman of the section, H. K. Hayes, in which he presented an illuminating picture of the rapid strides that have been made recently in China, where he has been engaged in special studies during the past year. This was followed by a series of eight papers dealing chiefly with various phases of pasture investigations.

H. B. Sprague, of the New Jersey Agricultural Experiment Station, discussed the possibilities of improvement in pasture herbage through the development of better strains of grasses and clovers. The native wild white clover appears to present exceptional opportunities along this line. "Watch the cow in her feeding habits," said D. B. Johnstone-Wallace, of Cornell University, in a discussion of pasture management in relation to the composition of the pasture. B. A. Brown, of Storrs Agricultural Experiment Station, pointed out the limitations of artificial clipping as compared to animal production as a basis of measuring response to pasture treatments. W. H. Pierre, of West Virginia University, showed the effect of superphosphate in increasing both phosphorus and calcium content of various pasture species. The significance of changes in chemical composition of pastures from the standpoint of animal nutrition was brought out in discussion of L. A. Maynard, of Cor-

nell University. He indicated that the feeding tests on rats and similar small animals may not be directly applicable to ruminants. This is especially true with respect to non-protein nitrogenous materials, which may be synthesized by biological action in the digestive system of the cow or sheep.

The American Society for Horticultural Science met in sixteen sections, with a presentation of 201 papers. A conception of the trend in horticultural research may be gathered from the nature of the sessions. There were three sections devoted to problems with tree fruits, three dealing with vegetable crops, two dealing with floriculture and ornamental horticulture, two dealing with mineral nutrition, one dealing with plant breeding, one dealing with plant propagation and rootstocks, and one dealing with fruit setting and embryo development. The broadening of the field of horticulture is clearly evident from these facts. Twenty years ago a horticultural program consisted almost entirely of papers on tree fruits. Vegetable crops have now reached an equal status with tree fruits, and ornamental horticulture and floriculture are forging rapidly ahead. Plant breeding and propagation and rootstock problems remain of about equal interest, with some indication that they are increasing in importance; while the new section devoted to fruit setting and embryo development indicates a growing interest in this phase of horticulture.

Joint sessions were held with the Potato Association of America and with the American Society of Plant Physiologists and the physiological section of the Botanical Society of America. This last-named session, sponsored by the Horticultural Society, dealt with mineral nutrition, including the minor elements, with E. J. Kraus, of the University of Chicago, as chairman. G. T. Nightingale, of the University of Hawaii, presented a paper showing the relation of potassium and calcium to nitrogen metabolism in plants; J. E. McMurtrey, Jr., of the United States Department of Agriculture, showed color photographs of symptoms of mineral deficiencies; W. H. Chandler, of the University of Chicago, discussed the problem of zinc deficiency, particularly as applied to horticultural crops in California; and O. F. Curtis, of Cornell University, discussed the movement of mineral elements in the plant. Additional papers were presented during other sessions on boron deficiencies in cauliflower, turnips, apples and peaches, showing that the mineral element and deficiency studies are of immediate concern to commercial practices.

Photosynthesis continues to be a major subject for discussion, including effects of carbon dioxide concentration, temperature, light and other factors. The president's address by Alex Laurie, of Ohio State University, given at the banquet, reviewed the research development of floriculture and ornamental horticulture. Liberty Hyde Bailey was also present and spoke upon the necessity for horticulturists to maintain a variety and species concept throughout their work, and not to overlook the taxonomic and systematic background essential to a thorough understanding of plant behavior. Motion pictures of insects, birds and plants were shown, featuring some interesting growth movements in plants.

The twenty-third annual meeting of the Potato Association of America included joint sessions with the American Society for Horticultural Science and the American Phytopathological Society. Progress in the solution of some of the nutrient problems of the potato crop was reported by Ora Smith, New York; John Bushnell, Ohio; Gilbert F. Lea and John B. Smith, Rhode Island; and C. H. Metzger, Colorado. In discussing the rôle of certain of the minor elements in potato nutrition, Hester and Carolus reported that the use of copper, manganese and zinc gave no yield increases under Virginia conditions. Considerable interest was shown in the discussion of the possibility of developing varieties resistant to diseases and possibly to insects. Workers from New York and Ohio reported a definite preference of certain insects for several of the commonly grown varieties.

The following officers were elected: *President,* Fred H. Bateman, of Grenloch, N. J.; *vice-president,* F. A. Krantz, of the Minnesota Agricultural Experiment Station; *secretary-treasurer,* William H. Martin, of the New Jersey Agricultural Experiment Station; *members of the executive committee,* Julian C. Miller, Frank W. Hussey, Ora Smith, C. H. Metzger.

SECTION ON EDUCATION (Q)

(Reports from William S. Gray, Harry A. Carpenter)

The papers presented at the opening session of the Section on Education related to individual differences and desirable adjustments to them. The factors that effect differences in emotional responses were considered by Daniel Prescott, of Rutgers University. His analysis led to the conclusion that variations depend largely upon differences in the meaning or significance of situations to individuals. The relation between maturity and achievement was discussed by S. A. Courtis, of the University of Michigan. The data presented showed that there is an intimate relation between these two factors when the achievement of an individual is interpreted in terms of his own growth curve and cycles of growth. Wide differences in the cultural knowledge of students was reported by A. R. Lauer, of Iowa State College.

Girls are inferior to boys and continue their growth longer than the latter. F. L. Fizpatrick, of Teachers College, Columbia University, found that expressed preferences for science topics were not consistent among students and indeed were quite unreliable. Ralph D. Spence, of Teachers College, Columbia University, emphasized the large importance of individual differences in graduate study and described the plan adopted by his institution in selecting an advanced curriculum in terms of clearly defined individual needs. Lindsey Blayney, of Carleton College, presented evidence of the value in providing individual help and guidance to students in mastering the grammar required in translating English into German.

The second session was concerned with studies relating to testing and the curriculum. Florence B. Stratemeyer, of Teachers College, Columbia University, emphasized the value of comprehensive examinations in improving instruction, and Ben D. Wood, of Columbia University, described the economy which could be effected at all levels in scoring tests through the use of the International Test Scoring machine. Arthur B. Moehlman, of Ohio State University, discussed the advantages of preparing social science materials by means of the coordinated efforts of specialists in the several departments comprising this general field. A report by G. W. Hutson, of the University of Pittsburgh, showed the increasing importance in Pennsylvania high schools of English and history and the decreasing importance of the foreign languages. As a result of an analysis of science curriculums in the United States and England, Benjamin C. Gruenberg, of the American Association for Adult Education, showed that the needs of the adult lay public are not considered, particularly their needs as consumers.

The third session consisted of reports of scientific studies from members and fellows. The problems studied were broad in scope and the findings were illuminating.

The fourth session was a joint meeting with the Section on Chemistry and the Division of Chemical Education of the American Chemical Society. The central theme related to the preparation of teachers of chemistry. The introductory papers by J. H. Simons, secretary of the Section on Chemistry, and William S. Gray, secretary of the Section on Education, represented the points of view of the chemist and the professional educator and identified the major controversial issues. The chief differences in the views expressed related to the function of general education, the relation of chemistry to general education and the nature of the general education needed by teachers. The discussion which followed, led by Ralph Powers, of Teachers College, Columbia University, and Ross A. Baker, of the College of the City of New York, contributed greatly to the clarification of thinking concerning the broader issues involved.

The meeting terminated with the joint dinner of the Section on Education and the Section on Psychology. F. B. Knight, of the University of Iowa, retiring vice-president of the Section on Education, summarized a series of studies in arithmetic which emphasized the wide range of types of learning involved in the simple operations of addition, subtraction, multiplication and division. His data showed also that pupils could be trained to sensitivity to the various types encountered. Robert M. Ogden, of Cornell University, retiring vice-president of the Section on Psychology, discussed the relation of naive geometry to art. He defined naive geometry as a sensibility to spatial relations and maintained that the naive apprehension of such relations provides the systematic foundations of art. "True works of art endure a geometric analysis which reveals the principles of their composition."

Morris Meister presided at the morning meeting of the American Science Teachers' Association. He introduced W. J. Humphreys, of the United States Weather Bureau, who discussed "The Composition of the Upper Atmosphere." After discussing the historical development of our present knowledge of the lower atmosphere, Dr. Humphreys presented the latest views concerning the upper regions of the earth's atmosphere and traced the scientific methods by which science attempts to solve its problems. This was of particular value to science teachers who are charged with development of scientific attitudes and training in the use of the method of science.

Oscar Riddle, of the Carnegie Institution of Washington, representing natural science, and Roy W. Hatch, of the Montclair State Teachers College, representing social studies, discussed "The Relative Claims of Natural Science and of Social Studies to a Core Place in the Secondary School Curriculum." Discussion of these papers was led by E. E. Wildman, director of science education, Philadelphia, and C. L. Bennighof, Western Maryland College. These papers will be printed later. It was evident from the interest displayed that this forenoon's meeting was outstanding in the annals of science teachers' meetings.

At the association's annual luncheon the speaker was Dr. Edwin G. Conklin, president of the American Association for the Advancement of Science, who discussed "The Aims of Science Teaching." The afternoon meeting was opened by an address, "The Next Ten Years in Science Education," by Otis W. Caldwell. Based upon much evidence in the way of past experiences, Dr. Caldwell pointed the way in which it seemed that science education should advance. This

paper was discussed by S. R. Powers, Teachers College, Columbia University.

Earl R. Glenn, of Montclair State Teachers College, discussed "The Need for a National Publication for Science Teachers." Mr. Glenn pointed out that teachers are now served by at least four important science journals—*The Chemical Education Journal, School Science and Mathematics, Science Education* and *Science News Letter.* Each of these journals is serving a section only of the science teaching profession. However, it appears to be financially impracticable to expect all teachers to subscribe to all journals. Moreover, there appear to be certain types of articles and certain phases of science education not now covered adequately by the existing journals. This paper was discussed by C. J. Pieper and by Louis J. Mitchell. The last speaker of the afternoon was John C. Johnson, of the State Teachers College, West Chester, Pa., who discussed "Desirable Training for Science Teachers." Dr. Johnson proposed a practical curriculum based upon a long study and investigation by members of teachers' colleges. The paper was discussed by O. E. Underhill, Teachers College, New Britain, Conn.

Following the general sessions a business meeting was held. The president reported for the organization committee, which held a meeting during the evening of December 30. At this time the tentative constitution was carefully considered and changes were made in the interest of simplification and clearing up ambiguous statements. Phillip G. Johnson, of Cornell University, reported the results of this conference, and that the revised constitution was approved by the organization committee. The revised constitution, therefore, becomes the constitution of the American Science Teachers' Association.

The treasurer, Homer LeSourd, Milton Academy, reported that the association had to date more than 110 charter members. It was also reported that the following organizations had indicated their intention to affiliate with the American Science Teachers' Association: National Association for Research in Science Teaching, Chemistry Teachers Club of New York, New York State Science Teachers' Association, Nebraska State Science Teachers' Association and Texas State Science Teachers' Association. Reports of representatives from other organizations indicate that many more will affiliate in the near future. To complete affiliation each organization must elect one or more delegates to the board of directors of the A. S. T. A., according to the constitution, and remit the required fee per delegate to the treasurer.

The president reported the very great help that had been given the A. S. T. A. by the executive committee of the American Association for the Advancement of Science.

The following officers were elected: *President,* Harry A. Carpenter, Rochester Schools, Rochester, N. Y.; *first vice-president,* Earl R. Glenn, Montclair State Teachers College, Montclair, N. J.; *second vice-president,* Jerome Isenbarger, Wright City Junior College, Chicago; *secretary,* Harry A. Cunningham, Kent State College, Kent, Ohio; *treasurer,* Homer LeSourd, Milton Academy, Milton, Mass.; *directors-at-large,* Morris Meister, director of science for junior high-school grades, New York City; G. P. Cahoon, Ohio State University, Columbus, Ohio; W. J. Klopp, supervisor of secondary schools, Long Beach, Calif. The officers elected a fourth *director-at-large,* and Otis W. Caldwell, general secretary of the American Association for the Advancement of Science, was chosen.

ORGANIZATIONS RELATED TO THE ASSOCIATION AS A WHOLE

(*Reports from Edward Ellery, Nellie F. Matlock, Margery C. Carlson*)

The Society of the Sigma Xi held its thirty-seventh convention on Tuesday afternoon. Delegates were present from 47 of the 68 chapters and 7 of the 33 clubs. The alumni committee reported the distribution of $2,000 as grants-in-aid to eight of the applicants. The president reported that certificates in commendation of research had been granted to 10 candidates from seven institutions in the fields of physics, chemistry and biology. During the year 1936 new chapters of Sigma Xi were installed at Carleton College and the University of Buffalo. Charters were granted to George Washington University, Carnegie Institute of Technology at Pittsburgh, the University of Utah and Oregon State College at Corvallis. The treasurer reported that the permanent invested funds of the society amounted to slightly over $38,000. The *Sigma Xi Semi-Centennial History and Record* will be published in February. Amendments to the constitution were adopted, bringing Sigma Xi clubs into official connection with the national organization, and giving club delegates to annual conventions the privilege of voting on all questions affecting the Sigma Xi alumni members and associates. Henry G. Knight, chief of the Division of Chemistry and Soils of the U. S. Department of Agriculture, was elected a *member of the alumni committee* for the ensuing five years to succeed himself; and E. J. Lund, of the University of Texas, was chosen as a *member of the executive committee* for the term of five years to succeed Henry V. Wilson, whose term of office expired in 1936.

The twenty-ninth meeting of the American Nature Study Society was held from December 29 to 31. On Tuesday morning there was a presentation of nature study, as developed in the leading nature camps in the country, and the significance of Hawk Mountain Sanctuary. On Tuesday afternoon the program consisted of discussions on the visual aids in nature study,

its worth and its influence in the life of a city. Most unusual was the rare picture of humming birds being fed from the hand of the speaker, Mrs. Laurence Webster. By means of the slow motion pictures, one was able to see the actual movements of wings and tails of these birds during flight. On Wednesday both morning and afternoon programs were given over to a discussion of the fundamental relations of science and education. This particular theme was developed by eminent nature leaders in the field of science. The president, E. Laurence Palmer, at the close of the afternoon session presented a chronology of American nature study, showing movies of the late Mr. and Mrs. Comstock, John Burroughs and David Starr Jordan. At the Wednesday evening banquet Dennis Glenn Cooper, writer-photographer, gave an illustrated travel lecture in natural colors of "Isle Royale," our newest national park, presenting exclusive pictures of Isle Royale forest fires. The meetings closed on December 31 after a joint session with the American Science Teachers' Association.

The Sigma Delta Epsilon Graduate Women's Scientific Fraternity held a luncheon at which sixty members and guests were present. Virginia Bartow, Department of Chemistry, University of Illinois, presented the annual address on "Women in Chemistry." The business session was held during a breakfast attended by thirty-six members. Evelyn Fernald, Rockford College, Rockford, Ill., was elected president for the coming year.

REPORT OF THE COMMITTEE ON GRANTS

Your Committee on Grants in its meeting at Atlantic City on December 31, 1936, gave careful consideration to a total of 27 applications for research aid. The gross amount desired by these applicants totaled upwards of $10,000. We have had a total of $4,000 placed in our hands for allocation. As in previous years, this committee has looked with more favor on applications for research equipment and supplies than on indefinite items of travel expense and maintenance. We have not felt at liberty to make grants for the salaries of assistants.

Grants from the $2,000 fund appropriated by the American Association for the year 1937 are recommended by your committee as follows:

Harry F. Clements, for research on the mechanism of freezing resistance in the needles of *Pinus ponderosa* and *Pseudotsuga taxifolia*	$ 275
N. T. Bobrovnikoff, for an investigation on the spectra of faint celestial bodies	400
T. T. Chen, for research on the physical basis of heredity in unicellular organisms. The behavior of chromosomes in fission, endomixis and conjugation in paramecium in relation to problems of heredity and variations in Protozoa	225
Titus Carr Evans, for a study on the sequence of morphological and physiological changes following roentgen irradiation of insect embryos	200
Newell S. Gingrich, for an experimental study of the diffraction of x-rays by liquids	300
W. F. G. Swann, for an investigation of the contributions of secondaries and higher order radiations to the measured cosmic radiation, particularly with relation to the secondaries associated with the soft component	300
E. J. Workman and R. E. Holzer, photographic study of lightning discharge correlated with the electrical structure of the thunderhead	300
Total	$2,000

The fund of $2,000 made available to this committee for use in 1937 through the gift of Mr. Newcomb Cleveland has been allocated as follows:

Errett C. Albritton, for an investigation of (possible) action currents in the nerve tract connecting the supra-optic nucleus and the post-pituitary	$ 300
Alfred M. Elliott, for research on the nutrition of protozoa and to determine the effect of some ''plant hormones'' on the growth of a single celled animal	200
Wendell Gingrich, for research on the immunization and passive transfer of immunity in avian malaria	200
Walter S. Hunter and Clarence H. Graham, for a study of muscle and retinal potentials in connection with conditioning and vision	325
Dorothy Wolff, for moving-picture studies of the physiology of the labyrinth for correlation with microscopic sections	150
Emmett B. Carmichael, for a study of the relations of temperature to the toxicity of rattlesnake venom following its injection into animals	200
Laurence Irving, for a study of the O_2 and Co_2 capacity of the blood of fresh-water fish as a factor in respiration	200
G. Albin Matson, to determine the blood group distribution among the American Indians on reservations in Canada north of the Blackfeet Reservation	175
S. B. Barker, for a study of the metabolism of ketogenic materials by the depancreatized dog	250
Total	$2,000

It is only fair to say that applicants whose requests were not granted need not thereby feel that their propositions were considered unimportant. The committee believes that our list of applicants should be increased rather than decreased and that the announcement should make clear that grants are not usually given for salary or travel expenses.

Respectfully submitted for the committee,

(Signed) WALTER R. MILES,
Chairman

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SCIENTIFIC RESEARCH UNDER THE AUSPICES OF THE ROYAL SOCIETY[1]

By Sir WILLIAM BRAGG, O.M.

THE PRESIDENT OF THE ROYAL SOCIETY

THREE magnificent gifts have been made during the last few months for the furtherance of research in this country. In May it was announced that Lord Austin had placed a quarter of a million sterling at the disposal of the University of Cambridge to be devoted to the work of the Cavendish Laboratory. More recently still Lord Nuffield has presented to the University of Oxford a million and a quarter for post-graduate research in medical science. This afternoon the council of the Royal Society has accepted on behalf of the society a principal share in the responsibility for the administration of a sum of £200,000 bequeathed by the late Mr. H. B. Gordon Warren. The interest of this money is to be applied to the encouragement of research in metallurgy, engineering, physics and chemistry. The administering committee is to consist of eight members appointed by the society and two by the governors of Williams Deacon's Bank.

[1] From the Anniversary Address given at Burlington House on November 30.

These great gifts are naturally a source of deep satisfaction to the fellows of a society which was founded for the purpose of "improving natural knowledge." The givers are men who are or have been engaged in industry: which fact is itself a source of gratification. It is good to see that practical affairs are in accord with the realization of the vital importance of research.

Lord Nuffield's gift recognizes the value of research for the prevention and cure of disease. The obvious success which has already been attained in this way is sure ground for the expectation of further benefits commensurate with the magnitude of the new effort. Lord Austin's gift is for the promotion of investigations which are at the time devoted mainly to the abstruse problems of the atomic nucleus. The terms of Mr. Gordon Warren's bequest suggest a more immediate contact with industry.

Thus these benefactions differ widely in respect to their immediate purposes: but they all acknowledge the same principle, that the improvement of natural

knowledge is essential to the general welfare. As for our society, it is the basis of its charter and the reason for its existence.

The capital value of the funds administered by the society, if we include in them the Warren bequest, is approximately a million sterling. In this amount is also included the bequest of about £40,000 by the late Sir Joseph Petavel, to which reference is made in the report of the council. By far the greater part of the money has been received within the last twenty years. In 1828 Dr. Wollaston founded the donation fund, the first fund of which the income was to be devoted to research; the amount was about £3,400. By the beginning of this century there were several such funds, the combined income of which was £1,375. In 1912 the total income had risen to a little over £2,000 a year. Then in 1919 began a period of large donations. First came the Foulerton gift and the Foulerton bequest. The Messel bequest was received in 1921. The Yarrow and the Mond funds came in 1923, the medical research fund in 1924 and 1925. To these the Warren bequest has to be added. In all the society now directs the expenditure of about £31,000 a year on research. The direction makes a considerable demand upon the time and energies of fellows, and it is a pleasant duty to acknowledge their willing and able service on numerous committees.

The use to be made of these moneys is to a considerable extent limited by the terms of the respective trusts. Nevertheless, here is ample opportunity for a general policy at the discretion of the society. It is natural and right that special emphasis is laid upon general or fundamental research, so far as donors' wishes allow; and indeed the terms in which the donors have expressed themselves are favorable to research of that kind.

It is to be observed that many other bodies possess funds which are administered for similar purposes. In a list published by the Royal Commission for the Exhibition of 1851, the commission itself takes place as one of the oldest, and the Leverhulme Trust as one of the newest. The list includes such well-known names as the Carnegie Trust, the Helley Stewart Trust, the Beit Memorial Fellowship Trust and others. City companies are also to be found here. The improvement of natural knowledge follows also on the activities of many bodies that have specific applications in view. Each branch of the Defence Services maintains its own research laboratories; so do the Medical Research Council, the Department of Scientific and Industrial Research, the Agricultural Research Council, the Post Office, and so on.

Still more closely concerned with the direct applications of natural knowledge are the laboratories of the country's industries. Many of these are of great and established reputation. On the whole, the industrial laboratory is some way from being as frequent a factor in industry as it ought to be, but undoubted progress has been made in recent years.

This brief enumeration of some of the agencies making for the improvement of natural knowledge will serve as a reminder that the sum total of the work done in this direction is very large. It may fall far short of what is to be hoped for, but it forms an agency which begins to acquire a certain coherence, something which can be viewed as a whole and considered in respect to its character and its effects. It is beginning to find itself, like Kipling's ship.

An immediate and obvious effect is the increase in the volume of published results. The publications of scientific societies have doubled and trebled in size; and their treasurers are in many cases hard put to it to meet the consequent additional expense. Numerous industrial publications also contain records of special investigations. There is every reason for satisfaction with the increase in natural knowledge which has followed on the encouragement of research.

In certain respects at least the application of the knowledge acquired is also satisfactory, though judgment on that point will vary according to the position of the observer in a very large field. There are obvious improvements in the health and general well-being of the nation, in its industries, in the strength of its trade and in its powers of defence; and these are matters of primary importance. Though they may be no more than means to an end, they and the appropriate application of knowledge are a first consideration.

To such applications every kind of research may contribute; for even those who would have it that science must be followed without thought of its usefulness must admit that it has to be very pure science indeed which only meets with its application, as a straight line meets its parallel, at infinity. In general the encounter may be expected to come so soon that its effect has a present importance, and must be taken into account. The individual member of the society may keep his thoughts and his experiments within an isolated region, and so contribute what is due from him as a fellow. But the society as a whole must take the wider view and watch constantly the relations between scientific advance and the people who are affected by it. It accepts these responsibilities when it undertakes to administer the great sums that have been entrusted to it. In the early days of the society the fellows recognized duties in these respects, as the records of their "Transactions" show. Many of the founders occupied important positions in the state and their science bore directly on the needs of the nation. Throughout the three centuries of its existence, the same ideals have encouraged the activities of the society. At some times they have been less effective

than at others, but their general purpose has never been blurred. The whole of the work of the society is therefore an important part of a general effort to improve natural knowledge in the expectation of resultant benefit.

Another consequence of that effort deserves especial consideration. The increase of knowledge and its applications are, each in its own way, worth working for. At the same time there should follow, and does follow, an increase in the quality and quantity of men who can add to knowledge and use it; also, it may be hoped, an increase in the number of those who realize its effectiveness. This is an exceedingly important point. It might seem unnecessary to observe that the resources which a nation possesses are of no use unless there are the foresight and the skill which are needed to make use of them. Yet a nation as a whole might fail to act on a principle to which its individuals would give a ready assent. The principle has to be stated plainly, so that it may be widely understood. One of the greatest assets of a nation is the presence within it of men who are quick to apply the knowledge of the time to the needs of the time. There are many varieties of such men. There are the handicraftsmen, whose skilled fingers are guided by intelligence; their number is greatly increasing in this country, though the contrary is often asserted. There are those who can assemble and combine materials for a given purpose, and there are others who can seize upon the broad consequences of a new discovery and choose the right moment for setting the old to one side. History has shown many times how the fate of a nation may depend upon its capacity to use the knowledge and the materials at its disposal. One may be reluctant to draw examples from the catastrophe of the great war, but in its heated atmosphere developments came quickly to maturity. During its course engines and devices of all sorts came into being which, before the war began, had never been thought of seriously, if at all. Such were tanks, paravanes, sound ranging, wireless telephony, aeroplanes and a thousand contrivances in every section of the war on the ground, under the ground, on the sea, under the sea, in the air. Their invention and development would not have been possible if there had not been the men for the work. It was fortunate that the nation also possessed a body of young men—chemists, physicists, engineers, biologists—trained in the laboratories of universities, technical schools, polytechnics, and so on, and in industrial workshops who were able to understand and work with the new devices. I doubt if the value of those trained young men has ever been fully realized. If, unfortunately, another great war broke out, the devices of to-day would surely be modified or superseded during its course, and the process of development would begin all over again. Provided that the defence withstood the first shock, the men with knowledge of materials and skill in using them would be in demand as before.

Though war times may furnish the more obvious examples, the developments of peace follow the same road, at a slower pace. The major industries of this country have owed their advance in part to the national resources and to political relations, but largely also to the skill of the country's scientific and technological workers. The electrical trades depend largely on discoveries which she has made and has been quick to use. The same may be said of her metallurgical work, of her shipping industry, of her business in textiles, of the dye industry in which she has now taken a position which might have been hers from the beginning. The battle for the health and the nutrition of the nation depends for its success upon the same qualities. This becomes continuously more so as natural knowledge increases, and its technical use requires a more intelligent craftsmanship.

Many a similar instance might be drawn from past history. But the past differs from the present in this, that the knowledge then to be drawn upon was scantier and far less abstruse. It was related to the technical skill of the workshop rather than, as now, to the science of the laboratory. The agencies of change were such as the discovery of cast iron, the invention of printing, the design of the ocean-going chronometer, the eighteenth-century additions to the loom, and so on. To-day great matters turn upon the complicated physical science of the wireless valve or the intricacies of the internal combustion engine, or the highly skilled chemistry that brings assistance to medicine or the combination of physics and chemistry, biology and engineering involved in the preservation of food.

From this point of view the suggestion sometimes made that scientific workers might take a holiday looks more ridiculous than ever. No nation could afford such an intellectual disarmament in the face of the world; nor could the world itself in face of the evils that are to be overcome.

The position of the men, and especially of the younger men, who are encouraged by these financial aids to devote the most ingenious years of their life to scientific research must be considered by those to whom the ordering of their lives is due. Some of the most brilliant young men in the empire are selected for a specific purpose, which purpose they undoubtedly fulfil. Good work is done, and when it is finished a fine and most useful type of man is available for further service. In a great number of cases the satisfactory opportunity of further service presents itself. But it is not always so. It is possible to find a man living on income derived from one Research Trust after another until he ceases from age or other limitations to be eligible for further aid. His work may

have been excellent, and his competence as great as ever, but he finds that he must look in some new direction for his living. Academic businesses may be of no use to him, nor he to them. His occupation has led him up to a blind alley. I am told that there is a certain tendency for men who have been employed in industry as research workers to change over, where possible, to purely administrative work which is expected to be more lasting and in the end more remunerative. There is here a hint as to the true cause of the trouble. The blind alley should be a thoroughfare leading to occupations more suitable to the men and better fitted to get the best out of them. It is obvious what these occupations are. They are places of responsibility to which specialists in science are as yet but rarely admitted. There is an encouraging beginning, but it takes time to realize that the man who is in touch on one side with the growth of natural knowledge should be in close touch on the other side with the opportunities of its application. He should be an equal in the council chamber rather than a subordinate in the waiting-room. On the other hand, the scientific expert must himself help to take down the barricade that makes the alley blind. This requires that his education should be much more than sufficient to make him only a laboratory man: which brings us back again to the very important point that the man himself must be as much the care of those who give him research work to do, as is the work which they set before him. Obviously, the more complete the equipment of the man, the better the chance that he will make his way, and the wider his final influence. The bodies that administer research funds are already beginning to consult each other for the sake of better efficiency in the choice and direction of workers. As this becomes more general, there will surely be an effort to take a wider view of the responsibilities which the magnificent generosity of public men has placed upon them.

Reference is made in the report to a plan of research on malaria in India. I think that I may well amplify the reference by describing rather more fully the proposals of council in respect to Indian medical research, especially as it involves the adoption of a policy which it is to be hoped will commend itself to the society.

In 1924 the Royal Society received a legacy of £10,000, and in 1925 £28,108 19*s*. 6*d*., being part of the residue of an estate, for the prosecution of original research in medicine, for the prevention of disease and relief of suffering, with special reference to tropical diseases in British possessions. There are particular reasons associated with the gift for connecting its use with India. The council decided at its meeting on July 9 that the whole income, together with the invested income, shall be employed for five years (*i.e.*, until October 31, 1941) as follows:

A.—*Malaria research:* It decided to offer to Colonel Sinton, I.M.S., a stipend for five years to enable him to work at the Horton Centre on certain aspects of malaria. The Horton Centre will be under the control of the London School of Hygiene and Tropical Medicine, and unique opportunities will be available there for clinical study, for observations on the malaria parasite in man and *Anopheles*, for investigation of the serology and immunology of malaria and for chemo-therapeutic testing and experimentation on the human subject. Colonel Sinton is now, and has been for many years, actively engaged in malaria work in India.

B.—*Experimental studies on the ecology of certain species of Anopheles:* Where the control of malaria is successful it is nearly always achieved by measures directed against *Anopheles*. A detailed plan has been suggested by the London School of Hygiene and Tropical Medicine, by which a young man experienced in modern experimental zoology should be given opportunity for twelve to eighteen months, at that school, to learn about mosquitoes in general and the oriental species of *Anopheles* in particular, and should undertake experimental work in the physiology and behavior of *A. maculipennis*. He should then be sent for two and one half to three years to an appropriate center in India to carry out a program connecting malaria with the behavior of *Anopheles*. Council was informed that for the tropical portion of the scheme part of the cost could probably be met by the London School of Hygiene and Tropical Medicine. Assuming that this is the case, it decided that a sum up to £3,750 be offered provisionally, over a period of five years, to finance the project. A suitable investigator has been appointed in Mr. Muirhead Thomson.

C.—*Nutrition in India:* The existence of widespread malnutrition in India is beyond dispute, but more detailed and intimate information is required as to its incidence and effects. The council decided that Dr. C. Wilson should be offered a research grant for one year in the first instance, with possible extension for two more years, to enable her to make a survey of the nutritional condition of Indian families and to draw up a report. A study of the incidence of malnutrition among school-children, an investigation of dietary habits, an assessment of the value of foods in common use, etc., would be made in collaboration with the Indian Research Funds Association and with Dr. Aykroyd, its director of nutrition research. Dr. Wilson will be able, if necessary, to work for only part of the year in India, returning to England to carry out a statistical and experimental analysis of her results. One of her objects while in India will be to

build up and train a small body of collaborators by which the work will be aided and perpetuated.

The total estimated cost of the three schemes, over a period of five years, is £8,550. The council of the Royal Society believes that by a far-reaching plan of this character, involving work of three different kinds, all bearing on health in India, its medical research fund can be better employed than by small grants made from time to time for worthy but minor purposes. It could make good use of far more substantial funds on analogous lines.

Reference is made in the report of the council to the decision in the matter of the postal ballot; this required the invocation of a curious provision contained in our ancient charters. We were directed, in cases of a difference which we could not settle ourselves—and in this instance our legal advisers had been unable to settle it for us—to call in the services of certain high officers of state. This we did, and the officers in question responded promptly, taking, I believe, no little interest in this ancient direction and its present application. We are greatly in their debt for their very kind assistance.

The great increase in the amount of material to be published has brought with it certain serious inconveniences. It has always been the practice of the society to scrutinize with great care all papers submitted to it. Fellows have been ready to undertake this task, though, as we all know by experience, the labor involved is serious. Three times as many papers have now to be examined, as compared with a few years ago, and there has been no material increase in the number of those who are available as referees. It is not surprising that men who lead busy lives find it difficult to attend promptly to the work which they are asked to do, especially as the intricacies of modern science may make it necessary for a referee to devote days to any one paper. If there is much delay, there is disappointment at the tardy publication of matter which the writer naturally thinks ought to appear at once.

The council has considered this matter carefully and has come to the conclusion that in the great majority of cases the summary of a paper might be set up in type and distributed within a very few weeks of its receipt, without waiting for the verdict of the referees on the paper as a whole. A fellow who communicates a paper will, of course, take the responsibility for the summary. The reading of the paper and its publication in full will follow in due course, as the responsible committees advise, on receipt of the opinions of the referees.

Three years ago Sir Gowland Hopkins in his presidential address spoke with admiration of the work of the organic chemist and in particular of the "emergence of power to grasp the architecture of complex invisible entities such as organic molecules and the ability to construct them at will." He told how under modern methods of investigation the picture which the chemist had formed of the invisible molecule had actually taken shape. His picture-making had been amply justified. His stereometry was not, as some thinkers had maintained, to be swept away in favor of a mathematical symbolism. On the contrary, its usefulness would surely grow as the new methods were developed.

This anticipation has been fully realized during the last few years, mainly through the remarkable increase in the accuracy with which the structure of molecules, molecular aggregates and solid bodies in general can be determined. For this the methods of x-ray analysis of crystalline structure have been largely responsible. Moreover, other methods have been greatly strengthened by the example set by x-ray analysis and by its reactions upon themselves. Optical, electrical, magnetic and other properties have been successfully studied with the same great purpose, *viz.*, the correlation between the properties of a substance and the spatial arrangements of its components.

While the x-ray methods have been mainly useful in describing the arrangement of the atoms in assemblages surrounded by others of like nature and conditions, the methods of electron-diffraction are giving a remarkable insight into the modifications of arrangement that are to be found on surfaces. The extraordinary interest of such knowledge arises from the fact that natural processes so largely depend on surface actions.

For many years after its inception the x-ray analysis was, as might be expected, engaged in trying its own powers and learning how to apply them. It cleared up many structural problems on which older methods had little to say that was definite, as for example the distinction between ionic, metallic, adamantine and molecular compounds. Many crystalline structures were determined, and the results, as is well known, have been serviceable in a wide field of scientific research, and in many industrial processes. The methods of analysis, the technique and the interpretation of results have been greatly improved, as might be expected, by the researches of many hundreds of workers. The increase in accuracy is so great that new possibilities of usefulness come into view.

The improvement appears in two ways. In the first of the two, the measurements of the dimensions of the unit of pattern of a structure can now be made to one part in several thousand. Consequently, the determination of the electron charge e, made by the x-ray method, can stand beside the older determinations of the oil-drop method. There is a persistent discrepancy of about one part in two hundred, the former giving

the value 4.80×10^{-10}, the latter 4.77×10^{-10}; but it is clear that the larger value is at least as near the true value as the smaller. A full discussion of the x-ray method is given by Compton and Allison in their recent book on "X-rays," and a critical examination of some outstanding points is made by du Mond and Bollman.[2]

Again, as has been observed by Bernal, the use of high-precision determinations of the lattice constants of metals will soon become the most reliable gauge of purity of a metallic element. Accuracy has here been pushed to one or two parts in forty thousand. Again, the phase boundaries of an alloy can be very closely and conveniently defined by observations of such a character. Accuracy has been of great importance to the well-known work of Hume Rothery on alloy structures, and to the curious and very important relations between order and disorder in alloys which have been specially studied at Manchester.

The accuracy with which the position of each atom in the unit cell can be measured is of quite a different order. Thanks in particular to the use of Fourier analyses by J. M. Robertson and others, the distances separating the atoms, center to center, can be found to about 1 per cent., even when the complicated molecules of organic crystals are under examination. This is a great advance on the possibilities of even a few years ago, and it has important consequences. In particular, fresh light is thrown upon the problem of the chemical bond. At one time, single, double and triple bonds were considered to be distinct and definite phenomena. The tetravalency of carbon, for example, was described as an assemblage of four equal powers of combination, of which one or more might be exercised in the same direction. When the diamond structure was found by the x-ray methods, it was no matter of surprise that the four separate single bonds were displayed in the attachment of each carbon to four neighbors. In the structure assigned by the chemist to benzene, the fact that each atom had but three neighbors presented difficulties; various theories have been suggested in explanation, mostly little more than different ways of drawing diagrams, in which four single bonds were made to act somehow. In recent years, it has been more usual to propose that bonds may alternate between single and double, and that the tetravalency of carbon in the benzene ring is satisfied because three of the six links are double and three single, the two kinds alternating both in time and in order round the ring. The conception can be extended to cases much more complicated, provided that the two forms between which alternation occurs do not differ much either in form or energy. The effect is described as one of "resonance," a term due to Hund but applied to organic chemistry mainly by Pauling and his collaborators. Its bearing on structural chemistry was discussed by Sidgwick a few months ago in a presidential address to the Chemical Society.

When substances in which this "resonance" is supposed to occur are examined by the x-rays, it is found that the actual center to center distance of two atoms connected by alternating a link between single and double is characteristic of neither of the two extremes. These last two are definite quantities, and the length of the varying link lies between them. An actual link is rarely a pure single or double or triple link. Pauling and Sidgwick both discuss a number of cases in which the center to center distances can be correlated with a probable or possible amount of resonance. An excellent example is furnished by oxalic acid, which was examined by Zachariasen in 1934, but has just been remeasured by Robertson, using the powerful Fourier method of analyzing the observations. The distance between the carbon atoms is 1.43 A. The length of the single link of diamond is 1.54 A. The length of a double bond is very nearly 1.33 A. It might seem that in oxalic acid the link is actually more nearly double than single; but this is not so. A small proportion of double linking seems to shorten the distance considerably. For instance, each link in the hexagonal network of graphite must be two thirds single and one third double, yet its length is 1.41 A. In benzene, the half and half arrangement (following Kékulé) is correlated with a length of 1.39 or 1.40 A. Thus the actual length of a bond may prove to be a safe indication of its nature. Robertson points out that the oxalic acid molecule is always planar, which may be accounted for on the ground that rotation is restricted round a link which is even partially of a double character.

It has recently been shown by Bernal and Megaw[3] that in all probability there are two types of bond linking oxygen atoms through intermediary hydrogens. The one is the "hydrogen bond"; it is found, for example, in acids, and it corresponds to a separation distance, oxygen to oxygen, of 2.55 A. The other is the hydroxyl bond; it is found in a number of hydroxides, and its length is about 2.8 A. By the use of this conception it has been found possible to locate the positions of the hydrogen atoms in several hydroxide structures, particularly in the clayey mineral hydrargillite. The oxalic structure of Robertson seems to supply a new and interesting example of the difference between the two kinds of bond. One of the oxygens at each end of the oxalic acid molecule is bound to a water molecule in the crystal by a link 2.87 A, the other by a link 2.52 A.

[2] *Phys. Rev.*, September, 1936.

[3] *Proc. Roy. Soc.*, A, vol. 151, p. 384, 1935.

It has been pointed out[4] that the linking up of hydroxyl bonds explains the properties of the gels that are formed by neutral hydroxides.

These few examples may serve to show how improvements in the technique of x-ray analysis are sharpening a tool which has already been of assistance to research in many directions and now seems to be acquiring a new usefulness.

The chemist has already shown that the properties of the molecule depend on the internal disposition of its atoms. The characteristics of the solid state depend also on spatial relations, and in a manner which is even more complicated, much more complicated than in the case of the independent molecule. Accurate measurement of the spatial arrangements lays a firm foundation for the study of the properties of a substance in relation to its structure and its composition. The problems to be solved are, of course, extremely complex, but it is surprising how much can be done towards the examination of intricate molecular associations when the spatial relations between the most commonly occurring atoms are known. This applies, for example, to the study of the proteins which has already gone far; to the clays, and to the glasses and other extended structures. At one time it seemed hopeless to expect to learn much of the structure of bodies which were so irregular as to give no sign of crystallinity. But it is now possible to work from the regularity in occurrence of a few definite separation distances, even when regularity in orientation does not exist: and methods have been devised by which these distances can be determined by the x-ray methods.

It is clear, I think, that the stereometry which the chemist has developed so successfully is acquiring new powers which will have the widest applications.

SCIENTIFIC EVENTS

GERMANY AND THE NOBEL PRIZES

Following the award of the Nobel Peace Prize to Carl von Ossietzky, the German pacifist who was confined at the time in a concentration camp, Chancellor Adolf Hitler issued on January 30 a decree which reads:

In order to avert such shameful occurrences for all future time, I decree with this day the foundation of a German national prize for art and science.

This national prize shall be divided annually among three worthy Germans to the amount of 100,000 marks each.

Acceptance of a Nobel Prize is herewith forbidden to all Germans for all future time.

Executive orders will be issued by the Reich Minister for Popular Enlightenment and Propaganda.

At the Propaganda Ministry it was emphasized that the prohibition applied not merely to the peace prize, but to all Nobel awards.

The New York Times prints in full the statement made to the Reichstag by its president, Colonel General Hermann Goering, which reads:

Ridiculous insults which proceed partly from rage and partly from the bad taste of others can neither offend nor shame Germany. They merely fall back on those from whom they come, and especially on those who always pride themselves on their special good breeding.

When we see attempts to insult Germany before the world by awarding a peace prize to a traitor, to a person punished with penal servitude, then such action does not shame Germany but merely makes those ridiculous who are responsible for it.

But because Germany will not tolerate such shameful things in the future and does not want any dispute about them at all, the Fuehrer has created this day a national prize for art and science.

May the world realize from this that everything which it may undertake to insult the German people will always fall back on the other. It is, as the Fuehrer has repeatedly emphasized, a singular characteristic of present-day democracies to ignore facts and realities. But one must learn in time that the once torn and impotent Germany has been transformed into a proud, strong, honest, honor-loving, freedom-loving people—a people that has a right to be proud of its achievements before all nations, before history, before the future.

An Associated Press dispatch from Stockholm of the same date reports that Germany's ban on acceptance of Nobel Prizes by Germans will have no effect on the granting of awards by the Nobel committee. Professor Karl Manne Siegbahn, a committee member who won the prize for physics for 1924, asserted that the awards would be without regard for German laws, on the ground that no distinctions were possible between German and other scientists. However, whether payment is possible is a matter between the winner and his government.

A JOURNAL OF "PARAPSYCHOLOGY"

Duke University News Service has sent to Science the following release:

Establishment of a new scientific journal devoted to research in telepathy and clairvoyance has been announced by the Duke University Press. The journal will be called the *Journal of Parapsychology* and will be edited by Professor William McDougall and Dr. J. B. Rhine, with the assistance of Charles E. Stuart. It will be issued quarterly.

[4] Fricke, *Koll. Z.*, vol. 69, p. 312, 1934.

The rapid growth of the Duke experiments, and especially the development of similar work in other institutions of learning and elsewhere, has made it necessary to publish the journal to provide a proper outlet for articles in the field of study. The extraordinarily widespread public interest in this work, it is felt, justifies the founding of a magazine devoted entirely to these topics.

Parapsychology is a branch of psychology which includes such subjects as telepathy and clairvoyance and whatever other unusual capacities of mind may be discovered that do not fit into the recognized order of things. Although articles in the new Duke journal will be written in the usual scientific manner, they will not be unintelligible to the average educated person. The journal will have the special feature of presenting editorial abstracts of the articles to give the gist of each in non-technical terms.

The new journal is the first and only academic scientific journal devoted to the field of parapsychology. Though it is published at Duke, its columns are to be shared with other institutions where members are engaged in similar research.

Professor McDougall, eminent psychologist at Duke University, is a veteran in the field of parapsychology. He was formerly president of the English Society for Psychical Research and of other well-known organizations. He has been on scientific investigating committees and is considered the leading psychologist who has given his attention to the parapsychological branch.

Dr. Rhine has been in active charge of the experimental studies of clairvoyance and telepathy, or extra-sensory perception, as they are called, and has opened up through his book, "Extra-Sensory Perception," a new interest in these subjects and a new experimental attack that is world wide. Mr. Stuart is Prince memorial fellow at the Duke parapsychological laboratory and is the author of several articles on the subject.

THE FIRE IN LYMAN HALL OF NATURAL HISTORY, SYRACUSE UNIVERSITY

THE following is a brief report on the serious fire in Lyman Hall of Natural History at Syracuse University on January 11.

Smoke issuing from the roof of the southeast wing at about 1:20 P. M. was the first observed indication of the fire on the outside of the building; and smoke from the ceiling and walls of one of the rooms on the fourth floor was the first indication that those within the building had of the fire. It apparently did not arise in either of the laboratories or the museum.

The damage to the Natural History Museum is serious, as many of the exhibits are irreplaceable. The main losses in the museum were reported in SCIENCE, January 22.

Professor Ernest Reed, chairman of the department of botany, had his laboratory for genetics, mycology and plant pathology on the fourth floor. All the illustrative material for the course in genetics, mycology and plant pathology has been lost. The large research collection of cultures of Fusarium and other fungi which Professor Reed and his graduate students have collected during the past fifteen years was destroyed. Professor Reed has also lost notes and materials of his twenty years of study of inheritance in the sugar beet. At the present time he is on a collecting trip in Colombia and Venezuela and it has not been possible to get word to him of the destruction of his laboratory.

Professor Parke Struthers, of the department of zoology, was also located on the fourth floor. He was in charge of the courses in comparative anatomy and vertebrate zoology. The collections and equipment in these fields accumulated during the past thirty years is almost a total loss. Professor Struthers's chief losses are his collection of separates, his embryological material on the porcupine and numerous collections of skeletons.

The fire losses were limited to the fourth floor, but the water damage extends to the basement. A roof is being put on, and it is expected that classes will be able to return to the building by February 15 to use the three floors and the basement.

The university is protected by insurance. Professors Reed and Struthers will have to build entirely their research material.

I am wondering whether those interested in genetics, mycology and plant pathology may not have extra separates that they would be willing to contribute to the department of botany; or those in comparative anatomy and vertebrate zoology, separates that they would give to the department of zoology. Any such gifts will be appreciated and should be mailed to the Main Library, Syracuse University, and marked "For the Department of Botany" or "For the Department of Zoology."

W. M. SMALLWOOD

THE AMERICAN PHILOSOPHICAL SOCIETY CONFERENCE ON THE RESPONSIBILITY OF ENDOWMENTS

THE American Philosophical Society is sponsoring a joint meeting with representatives of foundations, societies and institutions administering funds in aid of research, to be held on February 19 and 20, in the hall of the society at Independence Square, Philadelphia.

On Friday, February 19, closed sessions, including round-table conferences, will be held from 10 A. M. to 1 P. M. and from 2 to 5 P. M., presided over by Dr. Edwin G. Conklin, vice-president of the society. Waldo G. Leland, permanent secretary of the American Council of Learned Societies, will open the discussion of some or all of the following subjects:

1. Grants-in-aid as distinguished from fellowships and scholarships.

2. Relative emphasis on projects and men.

3. To what extent should administration endeavor to seek out promising projects and men?

4. How best may reliable information be secured as to the merits of projects and the competence of applicants?

5. For what specific purposes should grants be made? *e.g.*, salary of applicant; travel and maintenance; assistance, technical and clerical; exhaustible supplies; equipment of lasting value, *e.g.*—apparatus, books, MSS, etc., and their ultimate disposal.

6. Desirable size limits of grants-in-aid. Should they be generous or limited to necessities?

7. Under what circumstances should grants be renewed, and should renewal be so frequent as to constitute continuous assistance?

8. What oversight or control should be exercised over the use of grants, the expenditure of money, the progress of research?

9. What have proved to be the most effective administrative devices for bringing systems of grants-in-aid to the attention of scholars, for handling applications, for assuring careful study of applications by experts and committees, and for making awards?

10. Is it desirable to promote large projects by relatively small grants from many sources?

11. Are prizes, whether competitive or honorary, an important means of promoting research?

12. Is it desirable to effect a better coordination among the various agencies that offer grants-in-aid, either as to the size of grants, the fields in which they are offered, or the overlapping of applications? What has been their distribution among fields of study and among grades of scholars?

Luncheon for members and invited guests will be served at 1 o'clock. At an open session on Friday evening at 8:15, Dr. Frederick P. Keppel, president of the Carnegie Corporation, New York, will speak on "The Responsibility of Endowments in the Promotion of Knowledge."

On Saturday morning an open session will be held at 10 o'clock on "The Most Important Methods of Promoting Research," as viewed by representatives of

1. Research Foundations and Institutions.
2. Learned Societies, Academies and Councils.
3. Universities, Professional and Technical Schools.
4. Research Workers and Recipient Institutions.

Roland S. Morris, president of the society, will preside over this session, and Dr. John C. Merriam, president of the Carnegie Institution of Washington, will make the opening address. A luncheon for members and invited guests has been arranged for 1 o'clock.

THE TWENTY-FIFTH ANNIVERSARY OF THE JOHNS HOPKINS SCHOOL OF ENGINEERING

THE Johns Hopkins School of Engineering will celebrate its twenty-fifth anniversary with a series of events beginning on Friday evening, February 19, with a diversified modern engineering exhibit. An address by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, will be given on the morning of the twenty-second at the sixty-first commemoration day exercises of the university. On this occasion honorary degrees will be awarded to several distinguished engineers.

On the morning of the twentieth, alumni, officials of the city and state and faculty members from other colleges will hear and discuss papers read by senior professors of the School of Engineering. These discussions will center about current research projects in which the members of the faculty have been actively engaged and concerning which numerous publications have appeared. The subjects will include high voltage insulation, electrical accidents, power development, water purification, gas engineering research and scientific motor vehicle taxation.

At four o'clock, on February 22, Professor Niels Bohr, director of the Institute for Theoretical Physics at the University of Copenhagen, will speak on "The Problem of Causality in Atomic Theory." Professor Bohr, who was awarded the Nobel Prize in 1922, will be a guest of the winner of the prize in 1925, Professor James Franck, now professor at the Johns Hopkins University. The lecture will be in the A. R. L. Dohme series. The concluding event of the program will be the alumni dinner at 6:30 in the evening. Abel Wolman, a member of the first graduating class, now the chief engineer of the Maryland State Department of Health, will be the principal speaker. His topic will be "The Engineer and Society."

Portions of the public exhibit will be devoted to the main branches of research and industrial engineering. Laboratory technique and facilities as well as instruction methods may be observed by visitors to the show. Many commercial appliances and processes will be brought in for the duration of the anniversary events and students will operate equipment and models reflecting recent discoveries. Several methods and pieces of apparatus developed at the Homewood laboratories will be demonstrated.

Early in the university's history President Daniel C. Gilman indicated his hope that the development of facilities at Johns Hopkins would witness the establishment of a school of engineering. That hope was realized in 1912 when the present dean of the school, Professor J. B. Whitehead, joined with Dr. Carl Clapp Thomas and Dr. Charles J. Tilden to form the department heads of the first faculty. On its twenty-fifth anniversary the school has three departments of civil, electrical and mechanical engineering accredited by the

Engineering Council for Professional Development. A department of chemical engineering has been recently established.

N. S. H.

RECENT DEATHS

LAWRENCE BRUNER, since 1895 professor of entomology at the University of Nebraska, died on January 30 at the age of eighty years.

JOHN H. GREGORY, since 1921 professor of civil and sanitary engineering at the Johns Hopkins University, died on January 18 at the age of sixty-two years.

JOHN ALEXANDER MACWILLIAM, until his retirement in 1927 with the title emeritus professor of physiology at the University of Aberdeen, died on January 13 at the age of seventy-nine years.

THE death is announced at the age of sixty-eight years of Percy Andrew Ellis Richards, for over twenty years professor of chemistry at Queen's College, London, and lecturer in chemistry and metallurgy at the Royal Dental Hospital.

THOMAS CROOK, since 1928 principal of the Mineral Resources Department of the Imperial Institute, London, died on January 6.

ORSO MARIO CORBINO, formerly professor of experimental physics at the University of Messina and later at the University of Rome, died on January 23 at the age of sixty years. In 1920 he was appointed a senator and in 1921 became Minister of Education in Premier Bonomi's cabinet. After the rise to power of Mussolini, he served for two years, 1923 and 1924, as Minister of National Economy.

SCIENTIFIC NOTES AND NEWS

AT the Founders' Day celebration of the University of Wisconsin on February 6, which commemorated the eighty-seventh anniversary of the opening of the first class of the university, special honor was paid to Dr. Edward Asahel Birge, president emeritus of the university, who is now eighty-five years old. Hundreds of alumni took part in the celebration by attending dinner meetings which were held in all parts of the country. At Madison a testimonial was presented to Dr. Birge by the alumni association in recognition of his long service to the university and the state. Dr. Birge went to the state university in 1875 as an instructor in natural history. He was professor of zoology from 1879 to 1911, and served as dean of the College of Letters and Science from 1891 to 1918. He was acting president of the university from 1900 to 1903, and in 1918, following the death of President Charles R. Van Hise, he was elected president. He served until 1925, when he retired as president emeritus.

THE council of the Geological Society, London, has awarded the Wollaston Medal to Professor Waldemar Lindgren, of the Massachusetts Institute of Technology, for his researches concerning the mineral structure of the earth, and especially concerning the problems of mesasomatism, contact ore-deposits and the application of physical chemistry to ore-deposition.

AN award for distinguished service to agriculture was made to Maurice Adin Blake, professor of agriculture at Rutgers University, at the opening session of the State Agricultural Convention in the Assembly Chamber at the Capitol on January 26. Professor Blake has developed some 100 new varieties of peaches.

THE Bulgarian Order of Civil Merits with Golden Crown has been conferred by King Boris III on Dr. J. C. Th. Uphof, of Orlando, Fla., in recognition of his researches in botany. These have been published in the English, French, German, Dutch and Spanish languages.

THE British Royal Astronomical Society has awarded its Gold Medal to Dr. Harold Jeffreys, university reader in geophysics at the University of Cambridge, for his researches into the physics of the earth and other planets and for his contributions to the study of the origin and age of the solar system.

DR. VILHJALMUR STEFANSSON was elected president of the Explorers' Club, New York City, at a meeting held on February 3. Dr. Walter Granger, whom Dr. Stefansson succeeds as president, was elected *first vice-president;* Lowell Thomas was named *second vice-president;* H. R. Forbes, *third vice-president;* H. E. Winship, *treasurer,* and Joseph Robinson, *secretary.*

DR. ROGER W. TRUESDAIL, of the Truesdail Laboratories, Los Angeles, has been elected president of the Sigma Xi Club of Southern California, and J. A. Hartley, president of the Braun Corporation, Los Angeles, has been elected secretary-treasurer.

AT the thirty-ninth annual meeting of the Washington Academy of Sciences, held on January 21, the following officers were announced for 1937: *President,* Charles Thom, Bureau of Plant Industry; *Corresponding secretary,* Nathan R. Smith, Bureau of Plant Industry; *Recording secretary,* Oscar S. Adams, Coast and Geodetic Survey; *Treasurer,* Henry G. Avers, Coast and Geodetic Survey; to the *Board of Managers* for three years, F. G. Brickwedde, National Bureau of Standards, and J. F. Couch, Bureau of Animal Industry; *Non-resident vice-presidents,* Thomas Barbour, Cambridge, Mass., and P. W. Bridgman, Cambridge,

Mass. Vice-presidents nominated by the affiliated societies were elected as follows: Philosophical, Frank Wenner; Anthropological, F. H. H. Roberts, Jr.; Biological, H. C. Fuller; Chemical, J. H. Hibben; Entomological, C. F. W. Muesebeck; Geological, W. T. Schaller; Medical, H. C. Macatee; Historical, Allen C. Clark; Botanical, John A. Stevenson; Archeological, Aleš Hrdlička; Foresters, S. B. Detwiler; Washington Engineers, Paul C. Whitney; Electrical Engineers, H. L. Curtis; Mechanical Engineers, H. L. Whittemore; Helminthological, Emmett W. Price; Bacteriological, H. W. Schoening; Military Engineers, C. H. Birdseye; Radio Engineers, J. H. Dellinger.

DR. WILSON G. SMILLIE, professor of public health administration in the School of Public Health at Harvard University, has been appointed professor of public health and preventive medicine and head of that department in the Cornell University Medical College, New York City. He will represent Cornell University in the supervision of the health center in Kipps Bay, Yorkville, now being erected in cooperation with the Department of Health of New York.

DR. GEORGE H. GODFREY, of the Pineapple Canners' Experiment Station at the University of Hawaii, has joined the staff of the Division of Entomology and Parasitology of the University of California at Berkeley.

AT the Massachusetts State College, Dr. C. E. Gordon, in charge of entomology, zoology and geology since 1930, has, at his request, been relieved of the direction of the work in entomology. The trustees of the college have voted to reestablish the department of entomology.

DR. WILLIAM CHRISTINE ANDERSON will retire as dean of the Brooklyn College of Pharmacy on September 1 and will become dean emeritus.

CLIFFORD C. GREGG has been appointed acting director of the Field Museum of Natural History, Chicago, to take the place of the late Stephen C. Simms, who had been chief executive of the museum since 1928. Mr. Gregg has been a member of the staff since 1926, and has served as assistant to the director under both Mr. Simms and the preceding director, the late David C. Davies.

DR. WALDO R. WEDEL has been appointed assistant curator in the Division of Archeology of the U. S. National Museum.

NANDOR PORGES has been appointed assistant bacteriologist at the By-Products Laboratory of the Farm Wastes Investigation Division of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture. He is stationed at Ames, Iowa.

DR. ARTHUR PAUL JACOT has been appointed a member of the Northeastern Forest Experiment Station, New Haven, Conn., where he will continue his work on the ecology of the fauna of litter and soil.

DR. BERWIND P. KAUFMANN, professor of botany at the University of Alabama, is on leave of absence for the second semester and will be a visiting investigator at the department of genetics of the Carnegie Institution of Washington at Cold Spring Harbor, Long Island, until September.

DR. MAX CUTLER, of the Medical School of Northwestern University, has a leave of absence, during which he will serve as visiting professor in surgery in the Peiping Union Medical College. He will conduct a tumor clinic under the auspices of the Rockefeller Foundation.

THE Committee on Scientific Research of the American Medical Association has made the following grants: Alexander S. Wiener, Jewish Hospital of Brooklyn, agglutinogens in human blood; Irving Graef, New York University, pulmonary reactions to instillation of lipids and mineral oils; Moore A. Mills, Northwestern University Medical School, experimental pulmonary tuberculosis in the dog; M. M. Wintrobe, Johns Hopkins University, red corpuscles; Edward S. West and G. E. Burget, diuretic action and chemical metabolism of sorbitol; S. J. Crowe, the Johns Hopkins University, physiology of hearing; Ernest Carroll Faust, Tulane University, epidemiology of trichinosis in New Orleans; George Herrmann, University of Texas, heart muscle chemistry; Paul M. Levin, the Johns Hopkins University, cerebral efferent tracts in primates.

DR. J. D. COCKCROFT will give a series of six lectures on the work on "Nuclear Physics and Low Temperature Research," carried out in the Cavendish Laboratory at the University of Cambridge, in the Jefferson Physical Laboratory, Harvard University, beginning on the afternoon of March 25 and continuing through the following week. Physicists who are able to attend these lectures will be welcome.

DR. THORVALD MADSEN, director of the Serum Institute, Copenhagen, will deliver the fifth Harvey Society lecture of the current series at the New York Academy of Medicine on February 18. Dr. Madsen will speak on "The Scientific Work of the Health Organizations of the League of Nations."

DR. T. WINGATE TODD, Henry Willson Payne professor of anatomy at Western Reserve University, will deliver the thirteenth Lewis Linn McArthur lecture of the Frank Billings Foundation before the Institute of Medicine of Chicago on Friday evening, February 26.

His subject will be "Objective Ratings on the Constitution, Based upon Examinations of Physical Development and Mental Expansion in the Growing Child."

DR. ALFRED C. LANE, professor emeritus of geology at Tufts College, lectured before the Society of Sigma Xi at the Ohio State University on January 7 on "Measurement of Geologic Time." Dr. Lane also spoke before the department of geology of the university on the afternoons of January 6 and 7 on "Radioactive Methods Applied to Pre-Cambrian Classification" and "Principles of Economic Geology."

PROFESSOR S. LEFSCHETZ, of Princeton University, gave recently a lecture in the Dohme series at the Johns Hopkins University on "What is Topology?" He also spoke before the Mathematics Club of the university on "Some Applications of Algebra to Topology."

PROFESSOR EDWARD KASNER, of Columbia University, gave two lectures in January at the University of South Carolina on "Infinity" and "Geometric Transformations."

DR. LEWIS W. HACKETT, assistant director of the International Health Division of the Rockefeller Foundation and representative of the foundation in Italy and Albania, is giving on Tuesdays and Fridays from February 2 to February 19 a series of six Lowell lectures entitled "Man against Malaria in Southern Europe."

THE Sigma Xi Chapter at the University of Rochester will hold its annual science exhibit on February 22. Dr. George Packer Berry, professor of bacteriology and associate professor of medicine in the School of Medicine and Dentistry, will speak to an audience of school children on "Viruses and Their Influence on Public Health." Dr. H. S. Gasser, director of the Rockefeller Institute for Medical Research, will deliver the evening address.

THE fourth annual meeting of the American Institute of Nutrition will be held in Memphis, Tenn., on April 21. Hotel headquarters will be at the Hotel Peabody. Officers for 1936–37 are: *President,* Dr. Eugene F. DuBois; *Vice-president,* Dr. Mary Swartz Rose; *Treasurer,* Dr. George R. Cowgill; *Secretary,* Dr. Icie G. Macy; *Members of the Council,* Drs. C. A. Elvehjem, R. M. Bethke and L. A. Maynard. There will be a luncheon and dinner at the hotel. The program will consist of approximately twenty scientific papers and the evening program will consist of six or eight discussion groups.

Nature reports that at the invitation of the Royal Society, the International Council of Scientific Unions will hold its triennial General Assembly at Burlington House, London, from April 27 to May 4. China, through the Academica Sinica of Nanking, has recently joined the council, which now includes forty-two countries in addition to the International Unions of Astronomy, Geodesy and Geophysics, Chemistry, Scientific Radio, Physics, Geography and the Biological Sciences.

THE Executive Committee of the International Union of Biological Sciences has decided to postpone the general assembly of the union from July, 1937, until the year 1940. The next assembly will be held at Stockholm immediately before the seventh International Botanical Congress, probably from July 11 to 20.

THE annual summer term of the American School of Prehistoric Research will open in Paris on July 1, 1937. The tentative program includes lectures, museum studies, practice in excavating and excursions in various parts of France, including the valleys of the Oise, Seine and Somme, the Dordogne region, the Pyrénées, etc. Excavations will be carried on at the important stations of La Quina (Charente) and Mas d'Azil (Ariège). The Abbé H. Breuil, foremost authority on old world prehistory, will be in charge of the course and will be assisted by Harper Kelley, associate director of the summer term, which will last for at least six weeks. Prospective students should apply for enrolment as soon as possible. Applications for enrolment and for further information should be addressed to: George Grant MacCurdy, director, American School of Prehistoric Research, Old Lyme, Conn.

THE Geological Society of America has recently authorized a grant assuring the publication of the seventh edition of the James D. Dana "System of Mineralogy," first published in 1877. This task of revision is expected to consume the time of two competent specialists for approximately four years. It is then to be published by John Wiley and Sons, New York, publishers of the original volume, and will take the place of the volume prepared under the direct supervision of the late Edward S. Dana, and published in 1892. The present work is being carried forward by Drs. M. A. Peacock and Harry Berman in the laboratories of Harvard University, under the supervision of Professor Charles Palache, of Harvard University, and Professor W. E. Ford, of Yale University.

BY the will of the late Miss Mary Lee Ware, of Boston, who made possible the glass flower collection at Harvard University as a memorial to her father, the sum of $300,000 is bequeathed to the university. The president and fellows of Harvard College are directed to divide the income from the $300,000—one

third going to the support of Rudolph Blaschka and Mrs. Blaschka, whose family made the glass flowers and models; one third to preserve the collection; and one third to pay the salary of officials of the museum in which the objects are housed. The will expresses the wish that the director shall give prominence in the museum to the educational and practical side, and shall endeavor to augment the usefulness of the museum of exploration and investigation. The wish is also expressed that the director have discretionary power under the president and fellows as to expenditures necessary. Other bequests include $40,000 to the Boston Lying-In Hospital; $20,000 to Harvard University for the work of the Cancer Commission; $40,000 to the Boston Athenaeum; $20,000 to the Massachusetts Society for Mental Hygiene; $10,000 to Berea College, Kentucky; $20,000 to the Massachusetts Eye and Ear Infirmary; $70,000 to the Boston Museum of Fine Arts, and $30,000 to Harvard College for the Fogg Museum of Art.

THE *Fondation Scientifique de Lyon et du Sud-Est* is offering a fellowship of 10,000 francs for a period of nine months to a graduate student of chemistry, preferably of industrial chemistry. A fellowship of 18,000 francs for nine months and free transportation in the Tourist Class of the French Line is being offered through the *Office National des Universités et Ecoles Françaises* to an advanced graduate student who has specialized in science, preferably one who has obtained a doctorate in mathematics, physical science, chemistry or biology.

DISCUSSION

HYDROPONICS—CROP PRODUCTION IN LIQUID CULTURE MEDIA

IN the late summer of 1935 a number of large growers of certain vegetables and flowers adopted liquid culture media on a large scale for the growing of crops and have (for two seasons) placed on the market products so grown to compete with those produced by agriculture. Thus further evidence has been established that production of certain crops without soil is practicable and it appears that the introduction into the economic field of a new method of production, essentially another origin of agricultural crops, may well be considered as the birth of a new art and perchance a new science which should be designated by a distinctive name. The first announcement of the probability of the economic feasibility of liquid culture media for production of some agricultural crops was in 1929—"Aquiculture a Means of Crop-Production."[1] This announcement was made about two years after the investigations were started to establish the basis for the use of liquid culture media for the commercial growing of crops. Liquid culture media had been extensively used for nearly three quarters of a century for the growing of plants for study, but until the above reference no mention is found in the literature of investigations designed to apply the principle of water culture in a practical way to grow crops without soil. It was of course evident at the outset of the investigations that cultural techniques had to be designed to establish the physiological basis for the method within the framework of economic feasibility. The physiological basis is the markedly greater productive potentiality of certain crops grown on a per unit area of specially prepared nutrient water surface than that of a similar area soil. It is the manyfold larger production of some crops per unit area of water surface than that of soil which makes water culture economically feasible. A different point of view was required for the organization of the investigations leading to establishment of a method of crop production without soil, than that which prevailed in classical plant physiology using nutrient solutions for growing plants as material for experimental study.

As it is the purpose of this paper to give a name to this new method of production, no discussion will be entered into concerning the physiological basis on which it is founded. In other papers, consideration will be given to this and also to the economic and to the sociological features arising out of the development. However, a brief statement of the historic aspects of water culture experimentation appears in order in considering a name.

While it had been known before modern science took form that certain plants would develop roots and make some growth in water, nevertheless water culture proper dates from those experiments in which the elements found in plants and known to be derived from the soil were added to water to make a nutrient solution. The credit for such experiments is generally accorded to Knop, whose first paper in Landwirtschaftlichen Versuchsstation appeared in 1859. Other names would be mentioned in a complete treatise on the origin and development of water culture experimentation, and cognizance given to the spirit of the day, the methods of the time and the view-point of agricultural chemists and plant physiologists for their part in the development. Knop, an agricultural chemist, conceived water culture as a means of elucidating soil processes in relation to plant growth, and such also has been the

[1] *American Journal of Botany*, 16: 862.

purpose of others who have used it. However, difficulty soon arose in the application of water culture data to soil problems and in time the method became more and more a feature of plant physiology rather than that of soil science.

Plant physiology used water culture as a means for study of plant processes and, as a consequence of the technique found necessary for such studies, data showing the great productive potentiality of liquid culture media were not obtained. The fact that water culture has been known to plant physiology so long, and has not heretofore been applied in a practical way, created the necessity for a name to be given the new development. The name also would draw distinction between two uses of water culture—the strictly scientific and the economic.

Because the term "aquiculture," as used by the author in the first announcement, had previously been used in other connections, being the designation given to the culture of aquatic plants and marine animals, it becomes necessary to select a new word. "Hydroponics," which was suggested by Dr. W. A. Setchell, of the University of California, appears to convey the desired meaning better than any of a number of words considered. Hydroponics has analogy in geoponics—the Greek term by which agriculture was known for several centuries in the middle ages; this word appears to have been in common use before the latinized term "agriculture" obtained universal standing. Furthermore, "hydroponics" (*hydro*, water, and *ponos*, labor) has a strong economic and utilitarian connotation; therefore it is desirable in view of the historic use of water culture in plant physiology. The word has not been used heretofore in a scientific sense, and hence there can be no objection as to prior usage.

W. F. GERICKE

UNIVERSITY OF CALIFORNIA
BERKELEY

TRANSMISSION OF THE VIRUS OF EQUINE ENCEPHALOMYELITIS BY AEDES TAENIORHYNCHUS

SINCE the initial discovery by the undersigned,[1] in 1933, that the mosquito *Aedes aegypti* is capable of transmitting the virus of equine encephalomyelitis, numerous additional transmission studies have been conducted by different investigators with various other mosquitoes. As a result some five or six additional species have been found capable of transmitting the disease.

During the latter half of the past year transmission experiments were undertaken with *Aedes taeniorhynchus*. These studies have definitely proved the ability of *Aedes taeniorhynchus* to transmit the "Western" type of equine encephalomyelitis from guinea pig to guinea pig.

In one out of a number of positive experiments a single mosquito feeding but once on a guinea pig produced the disease and death of the pig in five days. This was repeated with the same mosquito and another guinea pig, death of this pig from encephalomyelitis occurring in six days.

Transmission tests with *Aedes taeniorhynchus* and the "Eastern" type of virus, in so far as they have gone, have been negative. However, this phase of the study is incomplete and is being pursued further.

Details of the positive transmission experiments with the "Western" type of virus will be published in the near future.

R. A. KELSER

ARMY MEDICAL RESEARCH BOARD,
ANCON, CANAL ZONE

[1] R. A. Kelser, *Jour. Am. Vet. Med. Asn.*, 35: 5, May, 1933.

VITAMIN C IN PASTEURIZED MILK

SHARP[1] has recently drawn attention to the well-known effect of copper in accelerating the loss of reduced ascorbic acid in milk and has shown that this effect is smaller in milk pasteurized for 10 minutes at 77° C. than in milk pasteurized for 30 minutes at 62°–63° C.

As a result of his observation Sharp concludes that it is commercially feasible to produce copper-free pasteurized milk which will contain as much vitamin C as raw milk of the same age and that the main nutritional objection to pasteurized milk is thereby removed. The second conclusion is open to grave doubt for two reasons. First, cow's milk can not be regarded as an important source of vitamin C on account of low concentration of the vitamin in fresh milk and the uncertainty as to its preservation. Milk pasteurized in the most careful manner contains immediately after pasteurization only about 10 to 20 mg of ascorbic acid per liter. King[2] has estimated the daily human requirement at 25 mg for an infant and 40 mg for an adult, and recommends an estimated dietary allowance well above these minima. Thus an infant must take 2½ liters of the most carefully pasteurized milk in order to ensure ingestion of the mere minimum allowance of vitamin C. On the other hand, this quantity of vitamin C is contained in a relatively small volume of fruit juice.

Secondly, there are other milk constituents of which milk is the only source for infants and an important one for adults: and these may be harmed by pasteurization. For instance, pasteurization of cow's milk by the holder method renders its calcium less available for

[1] SCIENCE, 84: 461, 1936.
[2] *Physiological Reviews*, 16: 238, 1936.

the human infant[3]; and Sprawson[4] has found that raw milk protects children completely from dental caries—a most desirable result which has never been attained by the use of pasteurized milk or by any other therapeutic measures. Also, pasteurization makes cow's milk a less satisfactory food for the calf.[5]

Thus the destruction of some of the vitamin C can not be regarded as the "main nutritional objection" to pasteurizing milk. Two further points call for attention—the 2-6 dichlorophenol indophenol titration as used by Sharp for the estimation of vitamin C in milk is in our experience reliable when applied to fresh milk, but difficulties with the endpoint render it less reliable for milk samples 3 days old. And the postulated presence of an ascorbic acid oxidase in milk is difficult to reconcile with the observation that raw milk loses only about 50 per cent. of its reduced vitamin C on standing for 3 days at 2° C.

W. J. Dann
G. Howard Satterfield
Duke University

PARAMECIUM MULTIMICRONUCLEATA VS. PARAMECIUM MULTIMICRONUCLEATUM[1]

A communication from Dr. C. W. Stiles informs me that it has been customary to correct grammatical errors in the naming of animals, and that this procedure is automatically authorized by the word "must" in Article 14a of the International Code. ("Specific names are (a) adjectives which must agree grammatically with the generic name.") This rule must also be observed when a species is transferred from one genus to another. Thus, when *Xiphidium attenuatum* was transferred to *Conocephalus*, it necessitated changing the specific name to *attenuatus*, though I have seen *Conocephalus attenuatum* in print.

The above rule applies only to adjectives. If the specific name is a substantive in apposition to the generic name, Article 14b applies. Here the specific name need not agree in gender with the generic name, as the example given, (*Felix leo*), shows. Consequently, the specific name need not be changed when the animal is transferred to another genus. Suppose there were a species *X-us necator*, and this were transferred to a genus with a feminine name, as *Y-a;* the masculine specific name *necator* would not have to be changed to the feminine *necatrix*.

A point of historical interest and one which may explain some of the mistakes found in both botanical and zoological literature is the following. On the basis of the rule in Latin grammar that all trees are feminine, some authors have tried to extend this principle to all plants and to use only the feminine gender for all genera in botany, and conversely, only the masculine for all genera in zoology—this on the plea that it would make it easier to distinguish between zoological and botanical genera. This custom was not accepted by the International Commission.

John A. Frisch, S.J.
Department of Biology
Canisius College
Buffalo, N. Y.

GLASS GLOBES CROSS THE PACIFIC OCEAN

Glass globes are frequently found on the beaches along the western coast of North America. They are generally regarded as net-floats, used by Japanese fishermen, which have been carried by the Japanese current to the shores of America. They are reported to come ashore most abundantly during, and following, exceptionally strong storms. These globes have been known to the local inhabitants for many years. Hundreds are collected every season and sold to the tourists for souvenirs. News items regarding these curious objects have appeared in the local press, but no reference to them has been noted in the technical literature.

During the past several years, the writer has seen many of these floats which were found along the Oregon coast. These were generally made of green bottle-glass and ranged from two to eighteen inches in diameter. The globes float about three fourths submerged and the under-water portion is covered with a growth of marine vegetation containing many small shells.

These glass balls have been found the length of the Oregon coast and as far south as the Russian River in California. Their distribution is, no doubt, much greater than is indicated here. A few years ago a former student found similar globes on the north shore of the Island of Oahu; recently others have been mentioned from the Midway Islands.[1]

It would be of interest to learn more of what is known of the migration of these floats, such as the length of time required to cross from Asia to America, and also whether those found on our shores were beached immediately upon their first crossing or have made one or more circuits before stranding.

Vincent P. Gianella
University of Nevada

[3] A. L. Daniels and G. Stearns, *Jour. Biol. Chem.*, 61: 225, 1924.

[4] *Proc. Roy. Soc., Med.*, 25: 649, 1931–32.

[5] A. C. McCandlish and A. N. Black, *West Scotland Agric. Coll. Res. Bull.*, No. 4, 1935.

[1] John A. Frisch, S.J., Science, 84: 2178, 290–291, 1936.

[1] W. B. Miller, *The National Geographic Magazine*, 70: 6, 689, 1936.

REPORTS

THE COMMISSION ON CONTINENTAL AND OCEANIC STRUCTURE OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

I. HISTORICAL

IN 1932 the Dutch Geodetic Commission tabled a resolution advocating the appointment of a Joint Committee for the Study of the Earth's Crust for discussion by the union at its Lisbon meeting. It was resolved at Lisbon that the bureau of the union should appoint such a committee before the Edinburgh meeting in 1936. Early in 1936 the American Geophysical Union brought forward a similar, but perhaps more specific, proposition in advocating a joint discussion on "The use and value of geophysical methods in the attack upon the structural problems of oceanic and continental areas." The value of the cooperation of geologists is given special emphasis in this proposal. During the last Pacific Science Congress the same general question was also raised. On April 6, 1936, all associations were informed by the secretary of the International Union that a joint discussion would be arranged on the subject. As announced by the secretary on June 6, 1936, the president of the International Union called a "Committee on Continental and Oceanic Structure" into being, this committee to hold such scientific discussions, open to all those interested, as it considered desirable. The original committee consisted of 37 members as listed in the printed circular of June 6, 1936. R. M. Field was appointed chairman and H. Jeffreys was asked to collaborate with the president in organizing the collection and framing of the initial questions. The president of the International Union further suggested that the committee consider:

(a) The composition and personalities of a semi-permanent organization and office.
(b) The necessity for the tabulation and printing of essential data (such as the International Seismological Summary).
(c) Any other matters which require the approval and financial assistance of the General Assembly.

II. COMMITTEE MEETINGS

The meetings of the committee, at the request of the chairman, were open to all delegates to the Edinburgh Assembly. The following papers were discussed:

(1) "Recent Developments in the Geophysical Study of Oceanic Basins," by R. M. Field.
(2) "The Problems of Oceanic Structure," by H. Jeffreys.
(3) "The Importance of Submarine Topography and Geomorphology" (personal communication from D. W. Johnson), read by R. M. Field.
(4) "Recent and Additional Data Regarding the Significance of Oceanic Gravity Anomalies," by F. A. Vening Meinesz.
(5) "Terrestrial Magnetism and the Earth's Crust and Oceanic Structure," by J. A. Fleming.
(6) "Importance of Geophysical Methods, with Special Reference to Seismology," by N. H. Heck.

Recommendations as to the formation of a Commission of the International Union on Continental and Oceanic Structure were passed by the committee at its final meeting on September 21, 1936.

III. ACTION OF GENERAL ASSEMBLY ON SEPTEMBER 24, 1936

The General Assembly unanimously approved the formation of a Commission on Continental and Oceanic Structure and, with certain exceptions and amendments of the committee's original report, voted as follows:

(1) *Personnel of Commission:* G. Angenheister; R. M. Field, *chairman;* J. A. Fleming, *secretary;* B. Helland-Hansen, Harold Jeffreys, F. A. Vening Meinesz and O. T. Jones. It was the consensus of opinion that, rather than to greatly enlarge the membership of the commission, it would be wiser to coopt the services of experts in the formation of subcommittees.
(2) The commission shall pay particular attention during the next three years to the structural study of oceanic basins and their margins.
(3) The supporting nations shall be urged to create similar national committees.
(4) The chairman and secretary of the commission were instructed to take steps which would insure the distribution of the proceedings of the International Union, with special reference to the organization of the commission, to the International Geological Congress, the Pan-Pacific Science Congress, National Geological Surveys, National Geographic and Geological Societies and other national organizations and agencies whose abilities and interests are related to the aims and business of the commission.

The commission will deeply appreciate advice relating to any and all matters which have to do with the development of the geophysical exploration of that great international terra incognita, the sub-oceanic lithosphere.

R. M. FIELD, *Chairman*
JNO. A. FLEMING, *Secretary*

SPECIAL ARTICLES

THE ISOLATION OF TOBACCO RING SPOT AND OTHER VIRUS PROTEINS BY ULTRACENTRIFUGATION

A HIGH molecular weight crystalline protein, which available evidence indicates is tobacco mosaic virus,[1] was isolated from mosaic-diseased plants by chemical methods.[2] These same methods, when applied to plants affected by some of the less stable viruses, such as those causing tobacco ring spot, latent mosaic of potato, cucumber mosaic and severe etch, were successful only to the extent that partial purification and a limited degree of concentration were accomplished. In no instance was a crystalline protein isolated. The results, which were probably due to the instability of these viruses, and possibly to their low concentration, indicated that new methods would have to be developed in order to work successfully with such viruses. The observation that ultracentrifugation of the clarified juice from tobacco mosaic-diseased plants resulted in the separation of a pellet at the bottom of the tube,[3] and the demonstration by means of x-ray analysis[4] and virus activity measurements[5] that this pellet consisted of crystalline tobacco mosaic virus protein suggested the new methods that have been employed. If other viruses are high molecular weight proteins, it should be possible to concentrate and isolate them by ultracentrifugation.

This possibility was explored by ultracentrifuging the juice from leaves of Turkish tobacco plants diseased with tobacco ring spot virus, in 7 to 17 cc celluloid tubes, for about 3 hours in a maximum field of about 60,000 times gravity. Ring spot virus is unstable and becomes almost completely inactivated on merely standing at room temperature for one day,[6] hence it was necessary to keep the preparations cold during the entire manipulation. This was accomplished by working with the material in a room held at about 2° C. and by carrying out the ultracentrifugation in a quantity head[7] precooled to about 0° C. Since the centrifuge head spins in a vacuum, it absorbs but little heat, and during a 3-hour run usually warms up less than 5°. On ultracentrifugation of tobacco ring spot juice, which had been previously clarified by low-speed centrifugation in a Swedish angle centrifuge or by filtration through filter paper, very small pellets, less than 1/50th the size customarily found with tobacco mosaic juice, were obtained. Although about 80 per cent. of the amount of protein originally in the juice was found in the supernatant liquid, this protein was inactive and all the virus activity was concentrated in the pellets. Thus one ultracentrifugation served to separate the virus activity from the major portion of the protein. Since these pellets were so small and were found to contain much pigment and colloidal matter, several were combined, well suspended in 0.1 M phosphate buffer at pH 7 and spun on a Swedish angle centrifuge for 15 minutes. This served to further purify the protein, for much of the pigment and colloidal matter sedimented to the bottom of the tube. The supernatant liquid, which contained the soluble protein and a small amount of finely dispersed colloidal matter, was then ultracentrifuged and the whole process of alternate ultracentrifugation, re-solution of the protein and low-speed angle centrifugation was repeated 2 times. Each ultracentrifugation served to separate the high molecular weight from the low molecular weight material and to aggregate colloidal matter, and each low speed angle centrifugation separated this aggregated colloidal matter from the soluble material.

No protein could be demonstrated in the supernatant liquid from the third ultracentrifugation. The pellet which was obtained was found to contain but a trace of insoluble matter and to consist of crystalline protein. In the analytical ultracentrifuge a solution of this protein gave a sharp boundary characteristic of a single molecular species with sedimentation constant $S_{20^\circ} = \text{ca } 115 \times 10^{-13}$ cm. sec.$^{-1}$ dynes^{-1}. A total of about 10 mg of this high molecular weight protein has been prepared on 4 different occasions and the yield has varied from about 0.005 to 0.01 mg of protein per gram of starting material. This indicates that diseased plants contain about one part of this protein per 100,000 parts of plant material and hence that the virus activity of the protein concentrate might be expected to approach about 100,000 times that of the starting material. The virus activity of the protein has been tested on 10 different occasions and in every instance solutions containing but 10^{-7} grams of the protein per cc were found to be active and capable of causing necrotic lesions on cowpea,[8] *Vigna sinensis* Endl. Since the juice from plants diseased with tobacco ring spot virus, when similarly tested, was not found to be

[1] W. M. Stanley, *Amer. Jour. Bot.*, 24: No. 2, 1937.
[2] W. M. Stanley, SCIENCE, 81: 644, 1935; *Phytopath.*, 26: 305, 1936; *Jour. Biol. Chem.*, 115: 673, 1936.
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[8] W. C. Price, *Contrib. Boyce Thompson Inst.*, 4: 359, 1932.

active at dilutions greater than 1 to 1,000, the protein isolated by the ultracentrifugal method is about 10,000 times more active than the starting material. This tremendous concentration of virus activity and the very small yield of protein are in striking contrast to the results obtained in the case of mosaic-diseased Turkish tobacco plants, which were found to contain about one part per 500 of crystallizable tobacco mosaic virus protein, the activity of which was, therefore, only about 500 times that of the starting material.

As indicated by the great difference in sedimentation constants, the properties of tobacco ring spot virus protein are quite different from those of tobacco mosaic virus protein. The latter does not become denatured and loses practically no virus activity on short exposures to hydrogen ion concentrations between pH 2 and 3 or to temperatures up to about 70° C. It does not denature and its activity is not lost on standing for several days at room temperature. In marked contrast, tobacco ring spot virus protein is almost completely denatured and inactivated after one hour at pH 3, is completely denatured and inactivated after a 5-minute exposure to a temperature of 64° C., and is partially inactivated after one day and almost completely inactivated after 6 days at room temperature. Of interest is the fact that it may be more stable than tobacco mosaic virus protein towards alkali, for ring spot virus protein loses only a small amount of activity on standing for one hour at pH 9.6. It is, however, completely denatured and inactivated after standing for one hour at pH 10.8.

The serological properties of the 2 proteins are also quite different for, although the sera of animals injected with tobacco mosaic virus protein give a precipitate when mixed with solutions containing only 10^{-6} *gm of mosaic protein per cc, they fail to give a precipitate* when mixed with solutions containing as much as 10^{-3} gm of tobacco ring spot virus protein per cc. This property was put to practical use in the purification of one sample of ring spot virus containing a trace of tobacco mosaic virus protein as a contaminant. Antiserum to mosaic virus protein was added to the contaminated preparation, the precipitated mosaic virus protein was removed by low-speed angle centrifugation, and the ring spot protein was then separated from the excess antiserum by ultracentrifugation. It was thus possible to separate and remove mosaic protein from ring spot protein. These results demonstrate, as might have been expected from work with the crude juices,[9] that the mosaic and ring spot proteins are distinct serological entities. Further evidence indicating that the two proteins are different is found in the fact that the x-ray diffraction pattern of crystalline ring spot virus protein differs from that of crystalline tobacco mosaic virus protein. It has been possible, therefore, by a method involving use of the newly developed quantity ultracentrifuge, to isolate from Turkish tobacco plants diseased with ring spot virus a high molecular weight protein possessing the properties of ring spot virus and differing markedly from tobacco mosaic virus protein in its concentration in the plant and in its physical, chemical and serological properties.

This method has also been used in examining the juices of Turkish tobacco plants diseased with latent mosaic of potato (X-virus), severe etch and cucumber mosaic viruses, respectively. In the case of latent mosaic virus the pellets which were obtained were about 1/20th to 1/50th the size customarily obtained with mosaic juice and were found to contain all the virus activity. The protein in these pellets was also of a single molecular species with a sedimentation constant, S_{20} = ca 110, close to that of the ring spot virus protein. With severe etch virus the pellets were larger than those of latent mosaic virus and were also found to contain all the virus activity. The protein in these pellets sedimented more diffusely than did the ring spot and latent mosaic virus proteins, but the heterogeneity this indicates was probably the result of decomposition that occurred before the ultracentrifugal analysis was carried out. Although the boundaries obtained were too diffuse for accurate measurement, it was obvious that severe etch virus protein sediments at a rate comparable with that of the tobacco mosaic virus protein. When the juice from cucumber mosaic-diseased plants was ultracentrifuged, insufficient soluble protein for physical and chemical tests was obtained, despite the fact that all the virus activity was concentrated at the bottoms of the tubes. If, as seems to be the case, the dilution end-points of viruses may be used as a rough criterion of the amount of virus protein present in the host, then, since the dilution end-point of juice from cucumber mosaic-diseased plants is about 1 to 100, the amount of virus protein would be expected to be about 0.001 mg or less per gram of plant material. It would be necessary, therefore, to ultracentrifuge a liter or more of juice in order to secure a milligram of virus protein. Attempts to concentrate the juice before ultracentrifugation by means of precipitation with ammonium sulfate and solution in from 1/5th to 1/15th the original volume, although quite successful and useful in the cases of ring spot and latent mosaic viruses, were not successful in the case of cucumber mosaic virus, possibly because of its extreme instability.

The tremendous difference in the concentration of the various virus proteins in well-diseased Turkish tobacco plants is especially noteworthy. The concentration in the host ranges from one part per 500 for tobacco mosaic virus protein, through latent mosaic and severe etch to ring spot virus protein which occurs

[9] K. S. Chester, *Phytopath.*, 25: 686, 1935.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE ELECTRICALLY DRIVEN ULTRACENTRIFUGE

THE air-driven "vacuum" type of ultracentrifuge originally developed in this laboratory[1] has already found sufficient application in the different sciences[2,3,4] to warrant an examination of certain possible variations and improvements. Briefly, in the "vacuum" type of air-driven ultracentrifuge the large rotor (centrifuge) is both supported and spun inside a vacuum tight chamber by a small flexible shaft or tube which extends out of the vacuum chamber through an oil gland. The rotating parts consist of the large rotor (centrifuge) inside the vacuum chamber, a much smaller turbine above the vacuum chamber, which is both supported and spun by air, and the flexible shaft that connects the turbine to the centrifuge through the vacuum tight oil gland and lies in their vertical axis of rotation. Although the amount of air required to drive the air turbine is not large (2 to 3 cu. ft. per min., 15 to 20 lbs/in^2 gauge pressure in our latest design), the amount of air required to support the rotating parts is in comparison almost negligible and need only be supplied at from 5 to 15 lbs/in^2 gauge pressure. In many laboratories air compressors of sufficient capacity are not available, so that, in order to run the air-driven centrifuge, an auxiliary compressor must be installed. However, if it were possible to spin the turbine by some other means, the amount of air required to support the rotating parts could then be supplied by a small "blower" or compressor, which is available commercially at the cost of only a few dollars. In view of this and other reasons that will be given later, a study of the available ways of both supporting and driving the turbine has been undertaken, and the present note gives some of our results with an electrical type of drive.

Fig. 1 shows a schematic diagram of the type of apparatus used. A is the large rotor or centrifuge which is surrounded by the vacuum tight chamber V. S is the flexible shaft (1/16 in. rod or tube in the apparatus used), and T is the driving rotor. The vacuum tight gland or bearing G is mounted in round Duprene rings R and vacuum pump oil is forced into the hollow space between the two bushings B. The bushings are usually made of brass, bronze, babbit metal, etc., depending upon the material of the small shaft. Their construction has been previously described. The driving rotor T is supported on an air cushion between the bakelite collar C and T. Many

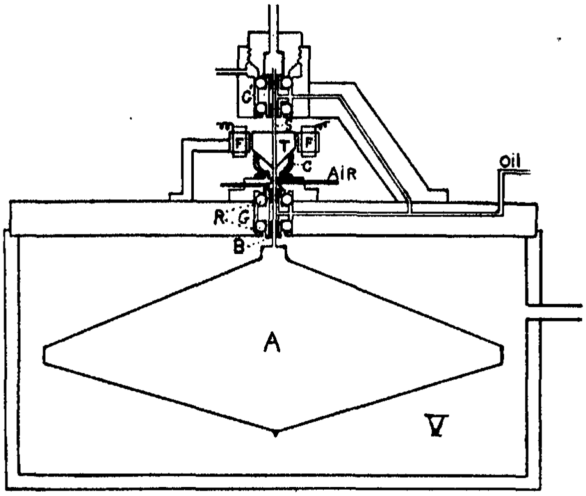

Fig. 1

variations in this air cushion support may be used[1] which are satisfactory. The upper bearing or gland G^1 is made similar to G so that when a tubular shaft S is used the rotor A itself may be evacuated. The driving rotor T is the familiar squirrel cage type of armature so that an alternating current in the field coils F causes it to spin. The principle of the induction motor is thus used to spin T, while a small amount of air at a pressure of a few lbs/in^2 is used to support it. The advantage of this type of electrical drive is that, if properly constructed, the centrifuge will start from rest and gradually accelerate until a rotational frequency is attained practically equal to that of the alternating current in the field coils F. The fact that in practice the rotor T reaches this speed results from the almost negligible friction except for that of the air on the small rotor itself. It is possible to construct electrical circuits and field coil magnets to give fields of considerable magnitude at the desired frequency so that the maximum rotational speed is set by the breaking strength of T or the centrifuge A. In most biological, chemical or medical experiments A is 8 to 10 inches in diameter and usually will explode if driven much above 1000 r.p.s. Hence in practice it is not difficult to construct T to stand this speed.

The A. C. supply for the motor was obtained from the inverter shown in Fig. 2. This is known as the double capacity single phase polycyclic type of inverter. For a detailed description of its characteristics and its mode of operation a paper by Sabbah[5] should be consulted.

The circuit was constructed from transformers, capacities, etc., which can usually be found in ...ied ...hen a ...this ele-

[1] Beams and Pickels, *Rev. Sci. Inst.*, 6: 299, 1935.
[2] Bauer and Pickels, *Jour. Exp. Med.*, 64: 503, 1936.
[3] Wyckoff and Corey, SCIENCE, 84: 513, 1936.
[4] Beams and Haynes, *Phys. Rev.*, 49: 644, 1936.

[5] C. A. Sabbah, *G. E. Review*, 34: 288, 1931.

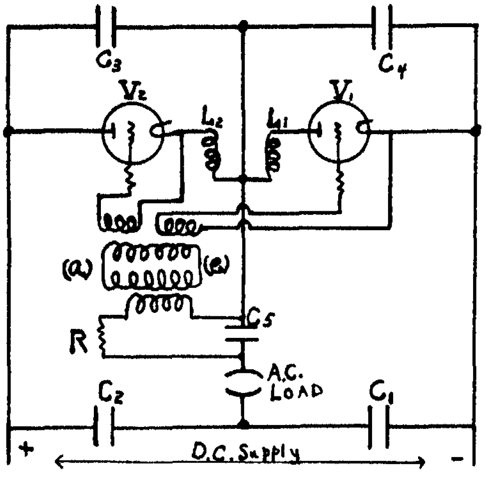

Fig. 2

laboratory or obtained at small cost. For the reactors L_1 and L_2 two windings of a one to one insulating transformer were used. Thyratrons FG-67 were used for V_1 and V_2. The grid excitation was obtained as shown. The frequency of the circuit could be changed by an alteration of R or by a change in any of the capacities C_1 to C_5. The circuit has good stability at any frequency under that at which the tubes V_1 and V_2 fail. This upper limit is well above 1,000 cycles with these thyratrons.

At times the circuit fails to start when the D. C. supply (about 250 volts) is connected. It may be started without producing failure by connecting the 60 cycle lighting supply through a resistance to the points (a) and (b). It is well to protect the tubes in case of failure by a fast circuit breaker or fuse of suitable capacity in the D. C. line.

This type of circuit is capable of furnishing considerable power at frequencies which can be changed gradually or abruptly by a variation in circuit constants. This is of advantage in the initial acceleration of the centrifuge as the frequency may be set initially at some low value and increased as the centrifuge speeds up.

Our experience shows that the induction motor type of drive gives a speed practically as constant as the frequency of the circuit and therefore better than usually required in most work. The heating of the rotor T gives no fundamental trouble because where accurate temperature control is required it is standard practice to maintain the vacuum chamber V at constant temperature by the usual thermostatic controls. If the air surrounding the rotor T is troublesome, T t... an easily be sealed in a vacuum chamber by a change tein. design. It should be pointed out that several other indic... of electrical circuits and drives may be used in the fi... that described above. The synchronous motor line ring s... drive has been used in this laboratory by Davis[6] to produce 1,400 r.p.s., while methods of driving high-speed electrical motors have also been devised, especially by Colwell and Hall.[7]

Although at present the air turbine drive must be used to obtain the very highest rotational speeds, the electrical drive serves equally well for many purposes and has the advantage, after once being set up, that it is automatic and requires no attention from the operator to keep the speed constant. This work will be continued, and we hope that a more detailed description can be published later.

J. W. Beams

L. B. Snoddy

University of Virginia

[5] K. S. Cl...

[6] T. Davis, *Rev. Sci. Inst.*, 7: 96, 1936.

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THE USE OF ISOTOPES AS INDICATORS IN BIOLOGICAL RESEARCH[1]

By Dr. AUGUST KROGH

PROFESSOR OF ZOOPHYSIOLOGY, UNIVERSITY OF COPENHAGEN

WHILE it is undoubtedly true that the chief tool and weapon in research is thought and ideas and that a large amount of experimental work in biology is more or less wasted for lack of thought, it is not less true that progress depends to a very large extent upon methods and that new methods may open up new and fruitful fields.

It is my task to-day to present some thoughts about a new and, as I believe, extremely powerful tool for biological and biochemical research: A small number of isotopes which can be readily distinguished and quantitatively determined by relatively simple physical means.

Isotopes are atomic species which differ in weight, but have the same nuclear charge and as a consequence of this last-named property they are practically identical chemically and will behave in the same way in organisms. Isotopes of lead are available in nature which can be recognized and quantitatively determined physically by their radioactivity, and recent progress is making available radioactive isotopes of a number of elements, including some of those which are of special importance in living organisms.

The methods for recognizing and estimating radioactive substances are highly developed and easy of application.

Hevesy, himself a pioneer in the chemical and physical study of isotopes, was the first to see the possibilities offered in biology by recognizable isotopes and made the classical and fundamental experiments with radioactive lead in 1921.

Attempts over several years to separate radium D from lead by chemical means had thoroughly convinced him of their identity, but the atoms of the one carried a label, so to speak, in their radioactivity. When a plant is grown in a solution containing lead, this ele-

[1] Address given at the Harvard Tercentenary Conference of Arts and Sciences, September 10.

ment will enter the roots and become distributed all through the plant, where it can be detected chemically and determined quantitatively in the ash of stems, leaves, fruits and so on. If after a certain time the plant is transferred to an ordinary nutritive solution, containing no lead, the quantity once taken up is retained and one would assume it to be firmly combined. If a radioactive variety of lead is used the detection and estimation becomes greatly simplified, but the really important point is brought out when a plant is grown first in a solution containing radioactive lead, until equilibrium is reached, and then transferred to a solution with the same concentration of ordinary lead and it is found that the radioactive atoms gradually leave the plant and are regularly exchanged with the ordinary variety, that in other words lead atoms are in reality never fixed anywhere, but are always on the move up and down the plant to and from the single cells, to and from the organic lead compounds which are continually formed and reformed. This concept of the lability of compounds and mobility of atoms within the living organism is fundamental, and it has been broadened and deepened by all subsequent research. It turns out in this particular case that lead atoms in organic combination within a plant can also be exchanged to some extent with other heavy metals, especially copper.

Lead is a decidedly foreign substance within an organism, and it might be thought that elements which were normal constituents of the tissues would settle down more permanently. Preparing a radioactive phosphorus isotope from ordinary sulfur Hevesy and his associates have utilized this substance for a number of experiments both on plants and animals which are still in progress. Professor Hevesy has kindly allowed me to mention some of his results. On plants the results correspond closely to those obtained with lead; phosphorus atoms will travel constantly throughout the plant and be transferred during growth from old leaves to new and *vice versa,* showing much more extensive transports of substances from leaves to roots as well as from roots to leaves than hitherto assumed.

On animals it is found, and was perhaps to be expected, that phosphorus introduced by injection is almost at once distributed with the blood all over the body and becomes excreted through the kidneys and also to some extent through the gut. In one experiment on a human subject 20.3 per cent. of the radioactive phosphorus introduced was eliminated in 4 days through the kidneys and 2.5 per cent. through the gut. When in another experiment the phosphorus was taken by mouth 15.5 per cent. was eliminated through the gut and 17.9 per cent. through the kidneys, showing that quite an appreciable amount had not become absorbed.

Most of the radioactive phosphorus introduced into a mammal leaves the blood within a short time, exchanging with the phosphorus of the tissues. The exchange with the inorganic phosphorus is almost instantaneous, but also the organic phosphorus present in muscles and other organs comes gradually into an exchange equilibrium with the radioactive element.

To my mind the most interesting result is the extensive exchange taking place in bones and teeth. It is, of course, well known that the organism is able to draw upon the skeletal system as a reserve of inorganic salts, but even remembering this I have never before been able to look upon the atoms deposited in practically insoluble salts and at a considerable distance from any blood vessels, in the dentine for instance, as being in constant interchange with the atoms of the salts in solution in tissue fluids and blood. This is, however, what the experiments clearly indicate. When a single dose of radioactive phosphorus is given to an adult rat and the animal is killed after one week 29 per cent. of the dose is found in the bones, 0.2 per cent. in the molars, 3.3 per cent. in the incisors (which are growing all the time) and 3.2 per cent. in the liver. When the rat is allowed to live on for one or two weeks more the content of radioactive phosphorus (corrected of course for the regular decrease in activity) gradually decreases, because replaced by the ordinary phosphorus of the diet. This decrease is conspicuous in the bones and in the liver, but has not so far been observed in the teeth, where the exchange is much slower. When the long incisors are cut in pieces and the growing roots, a middle portion and the tips, which one would expect to be quite outside any circulation, are examined separately it is found that even here the radioactive phosphorus penetrates and an exchange takes place. So far it has not been possible to examine the enamel separately and it is a matter for conjecture whether or not this, the hardest of all tissues, is taking part in the processes of exchange.

In young rats the exchange takes place more quickly, as one would expect, and relatively more is taken up by the growing bones and teeth, but on the whole the same relations are observed.

The heavy hydrogen isotope, called deuterium to distinguish it conveniently from the ordinary hydrogen or protium, is as an isotope in a class by itself. On account of the 100 per cent. difference in atomic weight and the fact that D and H may be present and act as naked nuclei, its chemical behavior is not exactly the same as that of protium. Several reactions carried out with deuterium are definitely slower than the corresponding ones with protium. The rate of hydrogenation of fats with deuterium gas, for instance, is only about half the rate for protium. The equilibrium

constant of numerous reactions in which deuterium participates is markedly different from that obtained with protium.

Several vital processes are slowed down by heavy water, deuterium oxide, and in high concentration it is harmful or even lethal to many organisms. With this aspect of the problem I do not propose to deal. The observations go to show that in concentrations below 10 per cent., where the deuterium is mainly present as DHO, heavy water behaves in the organism just as ordinary water and can safely be used as an indicator. Deuterium can be estimated with great accuracy as "heavy water" in mixtures with ordinary water by specific gravity determinations, and the chief difficulty is to purify the sample so that it contains only water. For the specific gravity determination itself fairly simple methods are available which are accurate to the 6′ decimal place, corresponding to 0.001 per cent. heavy water in samples containing from 0 to 5 per cent. over and above the 0.05 per cent. present in all natural waters. The falling drop method of Barbour can attain this accuracy on small fractions of 1 ml.

Heavy water can be utilized in the study of a variety of biological problems. It was shown by Hevesy and Hofer that D_2O either taken by mouth or, in aquatic animals, diffusing in through the integuments and gills, is rapidly and evenly distributed all over the body so that the concentration in the urine measures exactly the concentration in all the water in the body. We have attempted in collaboration with Hevesy to use D_2O to measure permeability, and important information can be gained, but there is a definite limitation to its use. It can show whether a membrane is permeable to water or not. In the eggs of certain fishes, notably the trout, there is a stage in which the vitelline membrane is stated to be impermeable to water. We have confirmed and extended this statement by means of D_2O. Immediately after laying, trout eggs swell by taking up water. Heavy water will penetrate at a rapidly decreasing rate, and after a couple of hours the penetration ceases. When at this state trout eggs are transferred to a heavy water solution not a trace of D_2O is found, even after a day or more, in the water to be distilled off from the eggs after they have been washed superficially with ordinary water. At a much later time, when the development of the embryo has reached the stage with just visible eyes, the membrane again becomes permeable so that water can pass in osmotically and, as no swelling is observed, excretion of water must be taking place. In all cases where it is desirable to find out qualitatively whether or not water can penetrate a membrane the heavy water can be used as an indicator of very high sensitivity.

In experiments on frogs we have been able to solve the much debated problem whether or not there is a selective permeability for water in one direction. When the legs of a frog are immersed in a known volume of, say 3 per cent. D_2O, the rate at which D_2O diffuses in can be ascertained and compared with the rate at which it diffuses out, observed when a frog is saturated with 3 per cent. D_2O and the legs immersed in H_2O. All the experiments made go to show that there is no significant difference in the diffusion rates outside $\rightarrow$ in or inside $\rightarrow$ out.

The diffusion rates measured with heavy water on living membranes are of a very low order compared, for instance, with collodion membranes, but unfortunately the heavy water can not be used to measure the rate at which water passes through a membrane by osmotic pressure differences. It is tempting to assume that a certain concentration gradient, say of one mole per liter of D_2O, can cause the same movement of D_2O molecules across a given membrane as the water movement brought about by a pressure difference of one mole of a substance which can not pass the membrane, but Jacobs has pointed out that the conditions are not comparable and it is certain that in the cases examined by us, mainly on frog's skin and on artificial membranes, the rates are very different and the osmotic water transport for a given pressure difference generally larger, while the proportion varies from one membrane to another.

A very large and, as I believe, very fruitful field of research is opened up by the observation that an exchange will take place between the deuterium atoms of heavy water and certain protium atoms of organic substances.

If a definite amount of an organic substance, a protein say, is dissolved in a suitable amount of water with a known content of D_2O and the water thereupon distilled off the D_2O content is found to be reduced, and when the dry residue is burned and the water formed by combustion from the hydrogen in the protein molecule is also tested the missing D_2O is found there.

At least with dilute solutions there is a definite relation between the D_2O percentage of the combustion water and the D_2O content of the water with which the protein was in equilibrium. For albumin we have found that the D_2O content of the combustion water is 40 per cent. of the distillate, and we take this to mean that 40 per cent. of the hydrogen atoms in the protein are in a labile state which allows them to continually change places with the hydrogen atoms of the surrounding water.

The experiments of Bonhoeffer and others have shown that hydrogen atoms directly attached to the carbon chain or ring are generally not liable to ex-

change, while the hydrogen of organic acids, hydroxyl, amino and aldehyde groups are readily exchangeable. In certain cases conditions are more complicated, as in the enol form of acetone or in maleic acid, where one or two hydrogen atoms are readily exchangeable to the outside, while a slow exchange can take place within the molecule between this and all other hydrogen atoms. In suitable conditions all the hydrogen atoms can therefore be exchanged with deuterium.

In a recent paper by Münzberg this slow exchange was specially studied on pyrogallic acid with the result that the exchange in 3 hydroxyl groups was practically instantaneous. One of the D atoms thus introduced could change places with one of the fixed H atoms by a keto rearrangement taking place at intervals, and this again could change places further by a spontaneous change in the place of the double bond, occurring at very long intervals. The final result was that all the 6 hydrogen atoms could be exchanged, but at ordinary temperatures this would take years.

It is possible to utilize compounds in which deuterium atoms have been built into stable positions and also the exchange processes themselves for the solution of important biochemical problems.

Schoenheimer and Rittenberg are working along the first of these lines. By the well-known process of hydrogenation they have built deuterium atoms into linoleic acid and fed the deuterium containing fat to mice. They expected to find that small amounts of fat given to animals on an insufficient diet would be readily oxidized, but they did find that even in these circumstances most of the fat was deposited before being utilized. When the fat is broken down in the body the deuterium is set free as heavy water which will become uniformly distributed in the body. In rats and mice in which the D_2O concentration was kept approximately constant over a period of a week or 10 days we (Ussing and Krogh) found small amounts of D in the body fats, indicating a new formation of fat from carbohydrate, a formation which it should be possible to measure quantitatively when the relative proportion of deuterium in carbohydrate and in fat formed from it can be determined. Schoenheimer and Rittenberg have also recently solved the long-debated problem of desaturation of fatty acids as a normal process in the living organism by showing that when saturated fatty acids containing deuterium were fed to mice, and the body fats extracted after a suitable period and fractionated so as to separate saturated and desaturated acids, an appreciable proportion of the deuterium was found in the desaturated fraction.

Schoenheimer and Rittenberg have pointed out the great possibilities for studying intermediary metabolism opened by introducing into the body substances suspected of being links in the chain of conversion and having these "labeled" with deuterium in a stable position. When this D is afterwards found in the normal end product of the series at least the possibility of the conversion in the body is proved. They have applied the procedure in the cholesterol-coprosterol series with very promising results, and I am convinced that they have hit upon a principle of very general applicability. I expect that in a not too distant future a series of organic substances containing D atoms in suitable stable positions will become available commercially.

In my laboratory Ussing and myself, in regular consultation with Hevesy, have made a number of preliminary experiments along the second line indicated. We exposed organisms to definite concentrations of D_2O to study the exchange between the water and the tissue substances. We hoped to be able to distinguish between a more or less permanent uptake of deuterium by new formation of tissue elements and a simple exchange, of the same type as that observed *in vitro*, but possibly different in amount, owing to essential differences in constitution between proteins as isolated and proteins built into living systems.

Our first experiment was done on four equal lots of peas which were soaked in water containing D_2O and then allowed to sprout in the dark for different lengths of time up to 10 days. Contrary to our expectation the maximum of deuterium in the dry substance was found just after soaking when deuterium was present in the dry substance corresponding to an exchange percentage of 26. Later on about 20 per cent. were found so that, apparently at least, no building in of deuterium into stable positions took place.

Frogs were saturated with about 1.2 per cent. D_2O, which is accomplished simply by keeping a small amount of water with an appropriate percentage circulating about them for several days. One frog was killed and analyzed while exposed in this way, and another transferred to a small volume of ordinary water, bringing the concentration down to approximately 0.4 per cent. In both cases the percentage saturation of the combustion water corresponded to 30 per cent., showing, apparently, that we have to do, at least in the main, with a simple reversible exchange.

In a series of experiments on rats and mice kept in a cage in a sealed metabolism chamber and maintained for varying lengths of time at an approximately constant concentration of D_2O in their body fluids the deuterium concentrations in single dry organs were measured and compared with the concentrations in the distillates from them, which were always identical for the whole body. In most organs a regular exchange took place, so that an approximate equilibrium in the neighborhood of 50 per cent. was reached within a few days, but the muscles behaved differently. In the

first experiments, which lasted a week or more, the deuterium concentration reached very high figures of about 70 per cent., but the increase was very slow, as shown in a one-day experiment on a rat in which the muscles had reached only 19 per cent. when the liver was 47. An experiment on three mice is especially instructive. These mice were brought by injection to about the same concentration of D_2O and kept together in the same metabolism chamber. One was killed after 1 day and showed in the proteins of muscle and bone an exchange of 11 per cent., while in the internal organs it had reached 20 per cent. The second mouse was killed after four days when the percentage saturation in the muscle and bones was 25 per cent. and in the internal organs 37 per cent. The remaining mouse was now given ordinary water to drink, which in 5 days reduced the concentration of D_2O in the body fluids from about 2 to about 1 per cent. The deuterium content in the proteins of the internal organs went down very nearly in the same proportion, showing now a 40 per cent. concentration, but in the muscle (and bone) the absolute content of D went up further, raising the proportion to 76 per cent.

It seems out of the question that a breakdown and reconstruction of muscular tissue should proceed at anything like this rate, and we are reminded of the slow exchange taking place within molecules referred to above. An exchange of this type might in the living organism be correlated with the activity, and to test this suspicion the following experiments were made on frogs with a suitable concentration of D_2O, in which one leg was denervated, while the other was stimulated to twitches at two to three seconds interval over 24 hours. We found an exchange of about 9 per cent. in the leg kept quiet and 12 per cent. in the leg which had performed about 36,000 twitches with an aggregate duration of less than 30 minutes.

It can not be sufficiently emphasized that the experiments so far made are preliminary and tentative. At the same time it seems to me that the general lability of substances and tissues in the organism already revealed is of very great significance and that we may look forward to important developments.

With regard to the utilization of heavy water as an indicator we are strongly in need of a comprehensive study of the exchange in protein substances *in vitro* both static and dynamic, studying the influence of conditions like pH, temperature, salts and so on on the final equilibrium and the rate at which it is approached.

There are, I believe, great possibilities for the further use of the hydrogen isotope in biology, but it must be admitted that the somewhat cumbersome technique of purification and determination of the deuterium oxide is in the way of rapid progress along this line.

From this great country with its enormous resources we may perhaps even look forward to the separation of other biologically important isotopes which can be determined by specific gravity methods. Still I think that the radioactive isotopes are likely to become of paramount importance because the determination is comparatively easy and the activity remains unaffected by any chemical treatment, including ashing.

The radioactive isotopes to be used in biology must possess a fairly strong activity which generally means a short radioactive life. On the other hand, the life, as characterized by the time of reduction of the activity to one half, can easily become too short for biological or even chemical purposes.

A large number of isotopes have been prepared with half times between a fraction of a second to a few hours. These will not as a rule be available for biological research.

The half time of radioactive lead (thorium B) is 11 hours and of phosphorus 16 days, which is very convenient for our purposes. A radioactive sulfur can be generated having a half time of 60 days and reports are presented of carbon with a somewhat similar length of life.

I am exceptionally fortunate in having become associated with Professor Hevesy and through him also with Bohr. The study of radioactive isotopes is to be pushed forward in Copenhagen, and a powerful plant is being erected for their generation. We are determined to do the best we can, but we cordially invite both competition, cooperation and criticism.

SCIENTIFIC EVENTS

LETTERS AND MANUSCRIPTS OF T. H. HUXLEY

In a letter to the London *Times* dated December 31, 1936, Lord Rayleigh, chairman of the Governing Body of the Imperial College of Science and Technology, London, and Sir Frederic G. Kenyon, chairman of the Friends of the National Libraries, have made an appeal for subscriptions to a fund to make possible the preservation of a unique collection of Huxley's letters and manuscripts, now in the possession of Mrs. Leonard Huxley. The letter follows:

"In your issue of February 14, 1936, you published an article by Sir Frank Heath describing the very interesting and historically valuable collection of letters and manuscripts relating to T. H. Huxley which are now in the possession of Mrs. Leonard Huxley.

There has been a general desire to preserve this unique collection as a whole and to house it at the Imperial College, where it could be studied by serious students and seen under suitable conditions by interested members of the public.

"In February last the governing body of the college issued an appeal to old students and friends of the college in the hopes of raising £2,000, the sum asked for the letters, and an additional £500 which is the estimated cost of binding and housing the collection. Before issuing this appeal they consulted the authorities of the British Museum and the Friends of the National Libraries, who are favorable to the scheme. The Friends of the National Libraries issued a supporting appeal to members of their association at the same time. Altogether a sum of £1,200 has so far been collected or promised. Of this, £464 has been received through the efforts of the Friends of the National Libraries, £150 has been granted by the Pilgrim Trust, £200 from one old student of the college, and £50 from Sir Robert Hadfield.

"The governing body and the council of the Friends of the National Libraries are most anxious to secure the additional money necessary soon. Otherwise it is probable that the collection will be broken up and lost to the country. It is possible that some readers of your paper have not yet heard of the appeal and would be willing to help to preserve the collection, which includes among other items of great interest almost the whole of Darwin's correspondence with Huxley, over 400 letters to and from Hooker, in addition to many hundreds of letters from Tyndall, Lyell, Herbert Spencer, Haeckel, Agassiz and many other men of great prominence in Huxley's time. It also includes many of Huxley's original manuscripts and notebooks.

"Contributions should be sent to the Secretary of the Imperial College, Prince Consort Road, South Kensington, S.W.7, or to the Secretary of the Friends of the National Libraries, care of British Museum, W.C.1."

RESEARCH ON METALS

THE rewards of cooperation in research in the field of metals through joint investigation of fundamental problems by physicists, metallurgists and chemists were discussed by leaders in these fields at a meeting held at the Massachusetts Institute of Technology on January 28 and 29 under the auspices of the institute and the American Institute of Physics.

The meeting emphasized the promising trend toward a most productive type of research in which technical workers bring to problems of fundamental interest the specialized knowledge and methods of their several fields. The very important results of joint research are nowhere more evident than at the institute itself, where many investigations are brought to successful conclusions through interdepartmental cooperation.

The purpose of the meeting was to discuss thoroughly recent developments in the physics and chemistry of metals, as well as the opportunities for still greater advances through the combined cooperative effort of all workers whose knowledge may in some way contribute to problems of mutual interest. From a half to one hour each was allowed for the presentation of important papers and ample time was given for discussion, thus permitting an interplay of viewpoints not possible in the usual scientific meeting.

Some of the more general papers presented were: "Research Problems in the Steel Industry," by Dr. E. C. Bain, United States Steel Corporation; "Inclusions in Ferrous Alloys," by Dr. A. B. Kinzel, Union Carbide and Carbon Company; "Flow Phenomena in Heavily Stressed Metals," by Professor P. W. Bridgman, of Harvard University; "Electronic Structures in Metals and Alloys," by Professor J. C. Slater, head of the department of physics of the Massachusetts Institute of Technology; "Corrosion," by Dr. J. R. Burns, of the Bell Laboratories; "Elastic Properties of Ferrous Alloys," by Professor A. V. de Forest, of the Massachusetts Institute of Technology, and "Chromium-Nickel-Iron Alloys," discussed by Dr. V. N. Krivobok, of the Allegheny Steel Company.

In another group of papers various techniques and their applicability were presented, while in the third group some especially complex scientific problems met with in ferrous alloys were discussed.

Arrangements for the meeting were in charge of Professor John Wulff, of the institute, who acted as secretary, and Dr. Harry A. Barton, director of the American Institute of Physics.

THE NORTHWEST SCIENTIFIC ASSOCIATION

THE thirteenth annual meeting of the Northwest Scientific Association was held on December 29 and 30, 1936, at the Davenport Hotel in Spokane, Washington.

President George F. Simmons, of the Montana State University, lectured at the general meetings on "The Mechanisms of Reproductive Periodicity in Mammals" and "A Windjammer Voyage to Treasure Island." Seven section meetings were held as follows: Bacteriology-Public Health, Botany-Zoology, Chemistry-Physics-Mathematics, Education-Psychology, Forestry, Geology-Geography and Social Science.

Officers elected for 1937 were: *President,* C. C. Todd, dean of the College of Letters and Science, State College of Washington, Pullman; *Vice-president,* J. H. Ramskill, professor of forestry, Montana State University, Missoula; *Secretary-Treasurer,* O. W. Freeman, State Normal School, Cheney, Wash.

Grants for research of funds contributed by private sources and received from the American Association for the Advancement of Science were assigned to: H. P. Klug, University of Idaho, "Photographic Records of Thermal Transitions in Substances," $50; J. H. Ramskill, University of Montana, "Development of the Hypoderm of Western Yellow Pine," $35; G. A. Matson, University of Montana, "Blood Studies of Montana Indians," $25; Dr. Van A. Odle, of Spokane, Washington, apparatus and materials for experiment on "Electrokinetic Potential of Red Blood Cells," $25.

It was announced that the Howard F. Flint Memorial Fund for research amounted to $1,031.30. The income from this will be used, beginning with next year, as a grant along forestry and biological lines.

O. W. FREEMAN,
Secretary

GRANTS IN AID OF RESEARCH BY THE GEOLOGICAL SOCIETY OF AMERICA

THE following is the list of grants in support of special research projects recently approved by the Geological Society of America:

A. A. Stoyanow, Tucson, Ariz. Grant of $1,000 covering field expenses in a revision of the Mesozoic sequence at Bisbee, Ariz.

A. O. Woodford and Edward Taylor, Claremont, Calif. Grant of $780 to cover living and traveling expenses in study of longitudinal profiles of streams, to be conducted in Europe during April and May, 1937.

Horace G. Richards, Trenton. Grant of $550 covering traveling and field expenses in study of the Pleistocene deposits and faunas of the Gulf Coastal Plain.

U. S. Grant, Los Angeles. Grant of $300 to be applied against field expenses and costs of preparing manuscript covering study of changes of the California coast.

F. H. Norton, Cambridge. Grant of $1,500 covering assistance and materials in study of hydrothermal action in minerals, particularly those that change into the clay minerals.

W. Armstrong Price, Corpus Christi, Texas. Grant of $1,200 covering traveling and field expenses of a reconnaissance of Pleistocene depositional plains of the northwestern Gulf Coastal Plain.

Charles T. Berry, Baltimore. Grant of $100 covering completion of illustrations for paper on "Ophiuran Remains from Upper Senonian of South Limburg, Netherlands."

Alfred C. Lane, Cambridge. Grant of $3,000 covering chemical analyses for studies directed to the determination of ages by the helium method.

W. E. Ford, New Haven, and Charles Palache, Cambridge. Grant of $24,000 covering assistance for four years to complete the seventh edition of James D. Dana's "System of Mineralogy."

Robert T. Hill, Dallas, Texas. Grant of $1,200 to cover expenses connected with history of geological investigation in the Southwest.

Committee headed by T. S. Lovering. Grant of $3,000 covering assistance and supplies in studies of the physical-chemical relation prevailing in a system consisting of a simple silicate and two volatiles at different temperatures and pressures.

John T. Lonsdale, Ames, Iowa. Grant of $850 covering field and office expenses connected with study of the petrography and petrology of the igneous rocks of the Terlingua quadrangle, Brewster and Presidio Counties, Texas.

AWARDS OF THE JAMES F. LINCOLN ARC WELDING FOUNDATION

THE James F. Lincoln Arc Welding Foundation, which was recently established by the Lincoln Electric Company, Cleveland, and named by the trustees in honor of its president, is dedicated to providing the public and modern industry with accurate knowledge and information on matters affecting the application of electric arc welding to machinery and equipment. One of its primary functions is the stimulation of original design, to utilize this process in modern-day fabrication.

To further this object it is planned to distribute the sum of $200,000 in 446 separate prizes for papers dealing with the subject as a primary process of manufacture, fabrication or construction in eleven major divisions of industry. The principal prize winner will receive not less than $13,700. Other prizes range from $7,500 to $100, the latter sum to be awarded to each of 178 contestants who receive no other prize, but whose papers are adjudged worthy of honorable mention.

In order to assure equal competitive opportunity, similar prizes are offered in the eleven major divi
of industry covered by the contest, which ar
subdivided to insure diversification of
entrant is required to select in advan
sub-classification to which his par
must actually have pa
which the subject-ma
cation follows:

Automotive—
$14,200; *aircr*
railroad ind
cars and l
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classified,'' $25,300; *industrial machinery*—process, construction, petroleum, steel-making, farming, household, food-making, textile and clothing, printing and ''not otherwise classified,'' $25,300.

Each entrant in a sub-classification will compete for five initial prizes of $700, $500, $300, $200 and $150 to be awarded within the sub-classification. From the winners of these prizes will be chosen four papers in each major industry to receive additional prizes of $3,000, $2,000, $1,000 and $800.

RECENT DEATHS AND MEMORIALS

DR. EDWARD CURTIS FRANKLIN, emeritus professor of organic chemistry at Stanford University, died on February 4 at the age of seventy-four years.

DR. DUNCAN STAR JOHNSON, since 1906 professor of botany at the Johns Hopkins University, died on February 16 at the age of sixty-nine years.

DR. FRANK SMITHIES, professor of medicine at the Medical School of the University of Illinois, Chicago, died on February 9 at the age of fifty-six years.

Nature records the following deaths: Sir John A. F. Aspinall, past-president of the Institutions of Mechanical and Civil Engineers and also of the Institution of Civil Engineers of Ireland, on January 19, aged eighty-five years; and of David Ellis, professor of bacteriology and superintendent of the Schools of Pharmacy and Bakery in the Royal Technical College, Glasgow, on January 16, aged sixty-two years.

A CORRESPONDENT of the *Journal* of the American Medical Association reports that a bust of the late Professor Babes, founder of the first Pasteur Institute in Bucharest, was unveiled in Bucharest on October 27. The bust is placed in the square, opposite the Bucharest Bacteriologic Institute. Memorial addresses were made by Professors Bacaloglu, Ciuca, Manicatide, Marinescu and Proca. At the same time the remains of Professor Babes were interred in the crypt situated in the garden of the institute. He died ten years ago and was buried in the Bucharest Greek Catholic cemetery.

SCIENTIFIC NOTES AND NEWS

THE Cardinal Newman Award for 1936 will be presented at the University of Illinois on February 21 to Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, New York City, for his contributions to medical science. The award is conferred annually upon the individual "who has made an outstanding contribution to the enrichment of human life in the fields of statesmanship, education, art, science or humanitarianism."

DR. RICHARD EDWIN SHOPE, of the department of
' and plant pathology of the Rockefeller In-
Medical Research, Princeton, has been
ohn Phillips Memorial Medal of the
of Physicians for 1937, in recogni-
viruses. The medal will
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W. R. Ham, head of the department of physics, served as toastmaster.

DR. CHARLES WALLIS EDMUNDS, professor of materia medica and therapeutics in the School of Medicine of the University of Michigan, has been appointed Henry Russell lecturer for 1937. The award was made possible by an endowment established in 1925 by the will of the late Henry Russell and is planned "to honor and reward that member of the faculty who is declared to have accomplished the work of greatest scholarly distinction during the year past." Another portion of the endowment is used to make an award to one of the younger members of the faculty who is believed to show the greatest promise in scholarly achievement. The name of the latter customarily is announced at the time of the lecture, which probably will be given in the first week of May.

DR. DAVID HILBERT, professor of mathematics at the University of Göttingen, celebrated his seventy-fifth birthday on January 23.

DR. W. G. CROCKETT, professor of pharmacy at the Medical College of Virginia, Richmond, has been elected president of the American Association of Colleges of Pharmacy.

OFFICERS of the Society of American Bacteriologists elected at the annual meeting in Indianapolis are: *President*, Dr. James M. Sherman, Cornell University, 'haca, N. Y.; *Vice-president*, Dr. Paul F. Clark, 'versity of Wisconsin; *Secretary-treasurer*, Dr. I.

L. Baldwin, University of Wisconsin; *Councilors-at-large*, Dr. Paul J. Beard, Stanford University, and Dr. Malcolm H. Soule, University of Michigan. Dr. F. G. Novy, of the University of Michigan, was elected an honorary member, and Dr. A. J. Kluyver, of the Technische Hoogeschool, Delft, and Dr. Th. Thjötta, of Oslo, were elected corresponding members.

DR. CHARLES SEYMOUR, professor of history and for the last ten years provost of Yale University, has been elected president to succeed Dr. James Rowland Angell, who retires in June, having reached the age of sixty-eight years. Dr. Angell has served as president of Yale University since 1921. He was previously president of the Carnegie Corporation, chairman of the National Research Council and earlier from 1894 to 1920 professor of psychology at the University of Chicago.

CHARLES E. MCQUIGG, since 1934 director of research of the Union Carbide and Carbon Corporation, New York City, has been appointed dean of the College of Engineering of the Ohio State University. He succeeds Emeritus Dean Embury A. Hitchcock, who retired last July.

PROFESSOR A. A. ATKINSON, for a number of years head of the department of electrical engineering at Ohio University, Athens, has been appointed dean of the College of Applied Science, which includes the departments of electrical, civil and industrial engineering, industrial arts, agriculture and the School of Home Economics. Dr. W. S. Gamertsfelder, professor of philosophy, has been made dean of the College of Arts and Sciences and of the Graduate College, succeeding Dean E. W. Chubb, who retired recently.

DR. WILLIAM HENRY WESTON, JR., professor of botany and chairman of the department at Harvard University, has been appointed visiting professor of mycology at the Johns Hopkins University.

AT the University of Oxford, Cyril Norman Hinshelwood, fellow of Trinity College, has been appointed to Dr. Lee's professorship of chemistry; Dr. Hugh William Bell Cairns, of Balliol College, has been appointed Nuffield professor of surgery, and Robert Reynolds Macintosh, Nuffield professor of anesthetics.

DR. WILLIAM R. MAXON, since 1914 associate curator in immediate charge of the National Herbarium in the U. S. National Museum under the Smithsonian Institution, has been made curator.

AT the recent annual meeting of the American Society of Zoologists, three new editors of *The Journal of Morphology*, to serve three years, were elected as follows: Dr. Leigh Hoadley, Harvard University; Dr. Wm. A. Kepner, University of Virginia, and Dr. J. Percy Moore, University of Pennsylvania.

PROFESSOR ARTHUR H. COMPTON, accompanied by Professor M. S. Vallarta, of the Massachusetts Institute of Technology, returned on February 11 from Mexico, where a permanent Cosmic Ray Recording Station was established on the grounds of the Mexican National Magnetic Observatory at Teolyucan, thirty miles north of Mexico City.

DR. R. K. NABOURS, head of the department of zoology at the Kansas State College and zoologist of the Agricultural Experiment Station, has been authorized to make a trip of approximately one month beginning on February 1, to southern Mexico for the purpose of collecting specimens of grouse locusts to be used as material for his experimental work. The trip is financed by a grant-in-aid from the American Academy of Arts and Sciences of Boston.

PROFESSOR OLIVER LEE, chairman of the department of astronomy at Northwestern University, has returned to the university after six months leave of absence, which he spent at the National Observatory at Tecubaya.

DR. NIELS BOHR, director of the University Institute for Theoretical Physics at Copenhagen, has been appointed to the Hitchcock professorship at the University of California, where he will lecture during the spring semester. He plans to give a series of public lectures and will hold daily conferences and colloquia with members of the departments of physics and chemistry. The Hitchcock chair was founded in 1872 by Charles M. Hitchcock, and his gift of $10,000 to endow a single lecture each year was augmented in 1932 from the will of his daughter, Lillie Hitchcock Coit, who provided $115,000 to endow the Charles M. and Martha Hitchcock chair, in memory of her father and mother.

DR. CLAUDE S. HUDSON, professor of chemistry at the National Institute of Health at Washington, gave the second series of Forris Jewett Moore lectures at the Massachusetts Institute of Technology on February 17, 18 and 19. This series is given under the auspices of the department of chemistry for the purpose of emphasizing the cultural and humanistic relations of chemistry. The general subject of the lectures was "Isomerism in the Carbohydrate Group."

DR. CARL D. LA RUE, professor of botany at the University of Michigan, addressed the Torrey Botanical Club at a meeting held at Columbia University on February 2 on "Studies in Morphogenesis and Plant Tissue Cultures." Professor La Rue has spent the past semester in research on plant tissue culture at Harvard University.

DR. DETLEV W. BRONK, professor of biophysics at the University of Pennsylvania and director of the

Eldridge R. Johnson Foundation for Research in Medical Physics, delivered the address to the graduating class on February 13.

DR. EARLE R. HEDRICK, professor of mathematics at the University of California at Los Angeles, delivered the address on January 25 at the annual dinner of the Santa Monica Chamber of Commerce. Dr. Hedrick spoke on "Royal Roads to Learning."

HOWARD BLAKESLEE, science editor for the Associated Press and president of the National Association of Science Writers, will be the commencement speaker at the Medical College of Virginia, Richmond, next June. Austin H. Clark, of the U. S. National Museum, has been invited to be Founders' Day speaker on December 1.

ERNEST H. ANTHES, of the Scientific Instrument Division of the Bausch and Lomb Optical Company, gave the Society of Hygiene Lecture of the School of Hygiene and Public Health of the Johns Hopkins University on January 27. The lecture, entitled "Microscopy through the Centuries," was illustrated by forty-nine lantern slides of early microscopes and a working model of Leeuwenhoek's microscope.

THE National Research Council announces a limited number of post-doctorate fellowships in physics (including astronomy), chemistry and mathematics for the academic year 1937–1938. Applications, including all supplementary documents, must be submitted in triplicate to the Secretary of the Fellowship Board in Physics, Chemistry and Mathematics, National Research Council, 2101 Constitution Avenue, Washington, D. C., not later than March 1. Application forms will be furnished upon request, together with a statement of general rules and regulations. Due to prospective modification in the administration of the National Research Fellowships, republication for 1937 of the usual pamphlet concerning these fellowships has been deferred.

THE University of Oxford is inviting applications for the Nuffield professorships of clinical medicine and obstetrics and gynecology. Applications must reach the registrar of the university by April 17. The salary in each case is £2,000 per annum. The senate of the University of London invites applications for the chair of pathology tenable at the British Post-Graduate Medical School, Ducane Road, W. The salary is £2,000 per annum, and the latest date for applications is April 16.

THE rector of the University of Panama, Dr. Octavio Méndez Pereira, reports that there is an opening there for an American physicist. Further information may be secured from the Institute of International Education, New York City.

Two Loubat prizes of $1,000 and $400, for "the best work printed and published in the English language on the history, geography, archeology, ethnology, philology or numismatics of North America" will be awarded at the Columbia University Commencement of 1938. The competition is open to "all persons, whether connected with Columbia University or not, and whether citizens of the United States of America or any other country." To be considered for the 1938 awards, books must be published before January 1, 1938. Dr. Waldo G. Leland, executive director of the American Council of Learned Societies, has been appointed chairman of the jury of award. Other members are Carl L. Becker, professor of modern European history at Cornell University, and Robert H. Lowie, professor of anthropology at the University of California.

A SEISMOGRAPH designed by Dr. Hugo Benioff, of the laboratories of the Carnegie Institute of Technology and the California Institute of Technology, has been given to Williams College by Mr. and Mrs. John S. Palmer, 2d, of Providence, in memory of their son Julius, who perished about two years ago on the Ward liner *Mohawk* with two senior classmates and Professor H. F. Cleland of Williams College. The instrument will be placed in two specially constructed tiled rooms.

Industrial and Engineering Chemistry reports that a contract was signed recently for the completion of the Museum of Science and Industry founded by Julius Rosenwald in Jackson Park, Chicago. The structure and the completion of the museum involves an expenditure exceeding $3,000,000 and will require some eighteen months to build. In order to avoid the necessity of closing the museum at any time, it has been arranged to hurry the completion of the west wing, so that space may be occupied there as required.

A DENSER network of weather observation stations, better synchronized and designed primarily to provide information for more detailed and more frequent forecasts for fliers, has been established by the U. S. Weather Bureau. About one hundred new off-the-airway stations began to make six-hourly observations on January 15. Temperature, precipitation, barometric pressure, visibility, ceiling, dewpoint, etc., are to be recorded at 1:30 and 7:30, both A.M. and P.M., Eastern Standard Time. The new observations will be coded immediately and wired either to Oakland, Calif., or to Chicago, where they will be relayed, by radio or teletype, over the entire airway weather system and also to regular Weather Bureau stations. The fifty or so off-the-airway stations already in operation and about one hundred selected stations on the airways will be equipped with the same kind of

instruments. The extra observations from the new, and newly equipped, stations will amplify greatly the information on which the forecasters at the six district centers of the Weather Bureau may draw in making daily weather forecasts for the United States.

THE first number of *Population Index,* a guide to current demographic materials for students, research workers and teachers, appeared in January. The *Index* is published quarterly by the School of Public Affairs, Princeton University, and the Population Association of America. It continues the association bibliography, "Population Literature." The current number contains two new sections, Current Items and Statistics, in addition to a bibliography covering more than 400 recent books and articles.

A QUARTERLY journal devoted to the integration of the scientific disciplines and to the study of the interdependence of science and society has recently begun publication under the title *Science and Society: A Marxian Quarterly.* The editors are A. E. Blumberg, E. B. Burgum, V. J. McGill, Margaret Schlauch and B. J. Stern. The foreign editors are J. D. Bernol, University of Cambridge; Lancelot Hogben, London School of Economics and Political Science; Paul Langevin, Collège de France; H. Levy, Imperial College of Science, London; H. J. Muller, Institute of Genetics, Leningrad; Maurice Dobb, The Marshall Library, Cambridge, and Joseph Needham, of Cambridge. Editorial communications may be addressed to the managing editor, W. T. Parry, 6½ Holyoke St., Cambridge, Mass.

FIFTEEN acres of woodland have been added to the Connecticut Arboretum at Connecticut College, New London, by a gift from forty donors interested in the development of the arboretum. The deed of gift specifies that the property shall be set aside forever as a wild-life preserve. The arboretum covers seventy acres within the college property and has been set aside for the preservation and propagation of the native plant life of Connecticut. Garden clubs, horticultural societies and other organizations and individuals throughout the state are cooperating with the college in its development.

DISCUSSION

ETYMOLOGY AND PRONUNCIATION OF THE WORD "OESTRUS" AND ITS DERIVATIVES

THIS word seems to offer more difficulties as to pronunciation and spelling than any other technical word in biology. Derived originally from the Greek *οἶστρος*, signifying the gadfly, and taken over into Latin as *oestrus,* the word came secondarily to mean frenzy or strong desire. The Latin derivative is properly of masculine gender, following the Greek, but we are told by Tyson[1] that some grammarians gave it the neuter form *oestrum* as early as 400 A.D. In its more general senses the word became naturalized in English with the spelling *oestrum* and has been so used in prose and poetic literature by many writers (see Tyson's article and the Oxford English Dictionary).

In the original Greek and Latin the meaning of the word already included, among other forms of excitement, the recurrent sexual impulse of animals. We owe its present definite technical use, however, to the late Walter Heape,[2] whose analysis and terminology of the phenomena of the reproductive cycle form the basis of research on that subject in the present century. As pointed out by Asdell,[3] Heape was not using the well-naturalized English word *oestrum,* which in English signifies any form of recurrent excitement (*e.g.,* the poetic frenzy), but was deliberately adopting the Latin word *oestrus* for use as a specific technical term meaning in English "periodic sexual excitement of the female." Writers having the latter significance in mind should, for the sake of precision, respect the difference and use the word *oestrus.*

It is scarcely necessary to point out that the nominative form is *oestrus,* and the adjectival form *oestrous* (*cf.* fungus, fungous; mucus, mucous).

As to pronunciation, the Greek and Latin diphthong of the first syllable has become in English merely a digraph, and in England is pronounced like long *e,* as in *thief.* Wyld's Dictionary of "Received Standard English" gives this pronunciation only. The Oxford English Dictionary gives also the short *e,* as in *yet,* as an alternative pronunciation, but by the time the Shorter Oxford Dictionary reached the letter O, the compilers had discovered that the short *e* is an American usage. The word *oestr* ...eems to have first appeared in the Americar ...ries in the 1860 edition of Worcester an(... Webster. In both cases the short pronun ... *e* was alone given. Webster continued to ...erence to this pronunciation, but since the ...vision cites also the long *e* as a non-preferred ...ciation. The Century Dictionary of 1911 g' ... long *e* only, but on the other hand the 1913 J ...nd Wagnalls gives the short *e* only.

It is eviden' ...refore, that the pronunciation of the non-techr ... word *oestrum,* and consequently of the technic ...m *oestrus, oestrin, oestrogenic,* etc., is

[1] Stuart L. Tyson, SCIENCE, 512: 74, 1931.

[2] Walter Heape, *Quart. Jour. Micros. Sci.,* n.s., 44: 1, 1901.

[3] Sidney A. Asdell, SCIENCE, 75: 131, 1932.

following a trend of American speech by which words beginning with the digraph *oe* tend more and more to be given the short vowel sound. The name *Oedipus* is another example. This tendency is reinforced by a corresponding tendency in spelling, to which H. L. Mencken calls attention in his book, "The American Language," namely, the conversion of decayed diphthongs into simple vowels, examples being *ecology, ecumenical, eon.* The editorial staff of the *Journal of the American Medical Association,* for example, has placed the word *oestrus* on a list of such words to be spelled without the *o,* a decision which is sure to influence the usage of American medical and biological writers. This mode of spelling has already been accepted as a variant in the 1934 revision of Webster's Dictionary, and will undoubtedly influence American pronunciation still further in the direction of the short *e.* In American speech, therefore, the short *e* should be used in pronouncing the word *oestrus* and its derivatives.

GEORGE W. CORNER
THE UNIVERSITY OF ROCHESTER
SCHOOL OF MEDICINE AND DENTISTRY

CARBONATION VS. CARBONATIZATION

IN recent years, there has been an increasing tendency to use the term "carbonatization" for "carbonation." The writer has been unable to find the initial use of "carbonatization," but it appears in Lindgren's "Mineral Deposits" (1913, p. 70), and in later editions.

Since 1913, "carbonatization" has appeared in various geology text-books and in various publications.[1] In most of these references, the term is used as indicating carbonation (*i.e.,* the union of carbon dioxide with some base) that takes place during weathering. It is also used for the same process in connection with the deposition of ores by hot waters. This note is a protest against the use of "carbonatization" for simple "carbonation" for the following reasons:

(1) The formation of a salt by the union of carbon dioxide with bases has long been, and still is, called "carbonation" by ch[illegible]ists. This is also the meaning given by all stand[illegible]naries, such as the Oxford, Standard, Century [illegible]er.

(2) The suffix "iza[illegible]ording to all the above-mentioned dictionaries, [illegible] form nouns of action from verbs ending in "iz[illegible] verbs having been formed by adding the suffix [illegible]o nouns or adjectives; the verb meaning to be [illegible]he thing denoted by the noun or adjective (Century Dictionary). None of the authors using "carbonatization" have used the verb "carbonatize," which would seem to indicate that such a word had not been found practicable.

(3) The word "carbonatization" is a clumsy, non-euphonious term, whereas "carbonation" is much simpler.

(4) In all the above references, the authors use the term "carbonatization" along with "hydration" and "oxidation," both of which latter terms they use in the same sense as chemists do. To be consistent, those who use "carbonatization" should use "hydratization" and "oxidatization." Pronunciation of any of the three words is a laborious process. Adding letters to words already in good usage and of sound meaning is not a desirable or worthwhile practice.

(5) The use of "carbonation" is preferred by most authors of text-books on geology, as is shown by the following list:

Chamberlin and Salisbury, "Geology," Vol. 1, pp. 43, 429, 1906.

H. F. Cleland, "Geology, Physical and Historical," pp. 35–37, 1916.

Hatch and Rastall, "Text-book of Petrology, The Sedimentary Rocks," pp. 155, 206, 313, 1913.

H. W. Shimer, "An Introduction to Earth History," p. 42, 1925.

J. H. Bradley, "Earth and Its History," p. 53, 1928.

G. W. Tyrrell, "Principles of Petrology," p. 173, 1926.

W. A. Tarr, "Introductory Economic Geology," p. 62, 1930.

Emmons, Thiel, Stauffer and Allison, "Geology," pp. 39–41, 1932.

W. B. Scott, "Introduction to Geology," p. 203, 1932.

Branson and Tarr, "Introduction to Geology," p. 62, 1935.

(6) The three terms, "hydration," "oxidation" and "carbonation," as used in reference to the respective processes taking place during weathering and rock alteration, by any process, have been in use so long and indicate so simply the nature of the reaction involved with each agent that there would seem to be little justification for introducing a hybrid like "carbonatization," which adds nothing to the previous good usage.

(7) The suffix "ization" has been added to various nouns (*e.g.,* pyrite → pyritize → pyritization), in discussions of sundry types of mineral deposits, to describe processes for which no previous word had been used. Many of these words are euphonious and desirable, but "carbonatization," being neither and being wholly unnecessary in the face of the priority of "carbonation," should, in the writer's opinion, be dropped.

W. A. TARR
UNIVERSITY OF MISSOURI

[1] W. H. Twenhofel, "A Treatis[illegible]Sedimentation," p. 15, 1932; H. Ries, "Elementary [illegible]omic Geology," p. 213, 1930, and "Economic Geolo[illegible] p. 491, 1930; R. H. Rastall, "Geology of the Metal[illegible]s Deposits," pp. 138, 142, and 162, 1923; C. R. Long[illegible]. M. Bateman and others, "Foundations of Geolog[illegible] 24, 1931.

SEEDLESSNESS IN TOMATOES

IN SCIENCE for December 11, there is an interesting news item,[1] presumably based on a recent paper[2] by Dr. Felix G. Gustafson, in which he describes the production of seedless tomatoes and other fruits as a result of treating unpollinated flowers with various organic acids. It might be of interest to some to know that this phenomenon, in the case of tomatoes at least, occurs in nature, under certain conditions.

In the Winter Garden Region of Texas, as in many other sections of the semi-arid Southwest, tomatoes will grow all summer long under irrigation, but, with the exception of some of the small-fruited varieties such as Red Cherry, they do not set any fruit. As a result of a cross between Large Cherry and Bonny Best some promising selections have been obtained which have larger fruit than the small fruited parent and which at the same time set fruits during the adverse hot dry months. The fruits of these plants contain seeds in June, and usually also in early July, but with the higher temperatures of midsummer, they become seedless. Only once in a while will one contain a seed. In November, the fruits are again seed-bearing. During this seedless period the plants bear just as profusely as at other times and the fruits are of fine quality. In view of Dr. Gustafson's studies it would seem that possibly the substances necessary for fruit formation are stimulated to develop under these Southwestern conditions—perhaps by the pollination process. Drs. Ora Smith and H. L. Cochran have shown that fertilization is often prevented under conditions of high temperatures (such as occur in Texas), even though pollination actually takes place.[3] Practically all varieties fail to set fruits if they are not fertilized, hence the peculiar characteristic exhibited by these tomato selections is an interesting one, especially so in the light of Dr. Gustafson's recent studies.

LESLIE R. HAWTHORN

TEXAS AGRICULTURAL EXPERIMENT STATION

A CASE OF INCORRECT IDENTIFICATION

GRANTIA is a sponge that occurs abundantly in Europe and figures largely in European text-books of zoology for that reason. Along the Atlantic coast of North America, and particularly at Woods Hole, Massachusetts, we have a sponge that bears a superficial resemblance to *Grantia*. Many years ago some one carelessly assumed that it was indeed that genus. A few moments are enough to show that such is not the case. *Grantia* Fleming 1828 has a distinct dermal cortex containing a special cortical skeleton of tangentially placed radiate spicules. The American so-called *Grantia* does not have such a cortex. Ours is no unknown genus, but one that has been familiar to students of sponges for over a century; it was named *Scypha* by Gray in 1821. A tentative identification as to species of the Woods Hole "Sycon" sponge may be given as *Scypha* (*Spongia*) *coronata* (Ellis and Solander 1786).

This affects a great deal of labeling in illustrations of American text-books, of museum specimens sold by biological supply houses, and especially labeling of prepared slides distributed by such companies.

M. W. DE LAUBENFELS

PASADENA, CALIFORNIA

ABNORMAL FEVER CASES

CASES of patients who show abnormally high temperatures for extended periods are occasionally reported. The conclusion in such cases is usually that some artificial means is being used to warm the thermometer.

The author has found such a means in addition to the usual suggestions of heating pad and hot-water bottle that might ordinarily be suspected. If a piece of dry cloth be wrapped about the bulb of a clinical thermometer and then the breath be blown against the bulb with considerable force, it is possible to raise the temperature to 106 to 108 degrees Fahrenheit, which is usually the limit of such thermometers.

An explanation of this, suggested by Dr. F. E. Poindexter, of St. Louis University, is that the water vapor in the breath is adsorbed by the fibers of the cloth. The heat of adsorption causes the rise in temperature above ordinary body temperature.

ONA K. DEFOE

THE ST. LOUIS COLLEGE OF PHARMACY

SCIENTIFIC BOOKS

MILLER'S COMPLETE WORKS

THANKS to the enlightened generosity of the University of Illinois the first volume of the collected works of George Abram Miller is now available to the mathematical public. In it are r papers, comprising Professor M to the theory of groups of finite r lished during the years 1894 are three essays on the ear written expressly for thi at pages 1, 91 and 42 a publication, but

[1] SCIENCE Supplement, 84: 7, 1936.

[2] F. G. Gustafson, *Proc. Nat. Acad. Sci.*, 22: 628–636.

[3] Ora Smith and H. L. Cochran, Cornell Univ. Memoir, 175, 1935.

pages represent Professor Miller's final judgment after some 40 years' continuous study of his subject. In them honor is given with meticulous care where honor is due. Here is something that can be read with interest and pleasure by every one into whose hands the volume may fall. It is hoped that more of this historical material will enrich the succeeding volumes. It is pleasing to see justice done to the Italian mathematicians, Ruffini, Abatti, Betti, Capelli, Veronese, Frattini, Giudice, Bianchi and Bagnera. No mention is made, however, of the admirable course of lectures delivered at the Ateneo of Madrid by the novelist, dramatist, statesman and mathematician, José Echegaray, and published under the title "Resolución de Ecuaciones y Teoría de Galois" in the year 1897.

The most remarkable thing known about groups of finite order was discovered by Sylow. Professor Miller brings out clearly how near Cauchy was to Sylow's Theorem, and one seems to read between the lines his regret that Cauchy did not have the good fortune to divine this great theorem for which he had a proof ready to hand. Indeed, it would have made a great difference to Jordan if he had had the use of Sylow's happy discovery when he was writing his great "Traité des Substitutions."

Since Professor Miller inserted these historical notes largely to define the place of his own work in relation to that of his predecessors and contemporaries one can criticize him only mildly for omissions. But he does not do justice to the many papers on group theory written by Jordan after 1870. For example, instead of the paragraph on page 447 devoted to the special theorem which asserts that if a primitive group of degree n contains a circular permutation of degree p (a prime) it is at least $(n-p+1)$-fold transitive, a theorem extracted from the Traité des Substitutions of 1870, it would have been better to have recalled Jordan's theorem of 1871, which may be stated as follows:

> If a primitive group G of degree n contains a transitive subgroup H of degree m, it will be at least $(n-m-2q+3)$-fold transitive, q being the greatest divisor of m such that the letters of H can be divided into systems of imprir ivity of q letters each in two or more different nr divisor of m has this property (as when H cyclic), G will be $(n-m+1)$-fold transi-

ot exactly an epigram, and is diffi- ut is far deeper and vastly more rlier special case that Professor ece of pioneering done by have been mentioned is roup of linear homo- s has an invariant Abelian subgroup whose index is less than a fixed limit depending on n alone.

There are other achievements of Jordan that might well have been mentioned. As it now stands, it may seem to a reader of the volume under review that Jordan is just one among many, while the fact is that the amount and quality of his work in this field place him head and shoulders above all but the astounding genius Galois.

Professor Miller is the recognized authority on groups of low order. This is the immediately useful part of the subject. The contents of this one volume alone are sufficient to justify this high compliment. His first great self-imposed task was to check and complete the lists of primitive groups of degree less than 18, and the intransitive and imprimitive groups through degree 10. Miller's lists do indeed seem to be final. At the same time he was engaged on a similar careful determination of the groups of low order, regardless of the degree. The eighteenth paper of this volume (page 131) gives a list of all the regular permutation groups whose orders are less than 48, and in its 38 pages all statements made are proved. In particular he corrected the fantastic assertion of Le Vavasseur that there are at least 75 groups of order 32, a number that was definitely fixed in this masterly memoir at 51. Here too is found for the first time the commutator subgroup and the proof that the quotient group with respect to it is Abelian, and that no proper subgroup of the commutator subgroup has an Abelian quotient group. This was an important advance in the use of the commutator: $s^{-1}t^{-1}st$.

In looking through this volume it is interesting to note the gradual growth of the abstract group idea. One elementary theorem that is now in constant use took form as that idea became clearer. It occurs twice (without proof) in this volume, and it is instructive to compare the two versions. On page 252 we find:

> If a group contains two self-conjugate subgroups that have only the identity in common, it may be represented as an intransitive group which is not simply isomorphic to any one of its transitive constituents.

Then on page 363 there is the more definite statement, referring clearly to an abstract group:

> If a group contains two self-conjugate subgroups (differing from identity) which have only identity in common, it can always be represented as an intransitive group which involves no transitive constituent whose order is equal to the order of the group. As such transitive constituents we may use the quotient groups (represented as substitution groups) with respect to the two given self-conjugate subgroups.

This seems to be the first statement of this fundamental theorem; but why did Professor Miller not

give a proof? It is probable that he visualized the two quotient groups side by side in two columns and "saw" that the resulting intransitive group would be simply isomorphic to the given abstract group, and propositions seen in this way are sometimes awkward things to put down in black and white.

The two papers in which the primitive groups of degree 15 and degree 16 are determined are models of their kind. In the second, page 270, it is shown in Miller's easy, graceful, flowing style that all the primitive groups of degree 16 (not alternating or symmetric) contain a self-conjugate subgroup in which every permutation is of order 2. This result suggests how inaccessible are the groups of degree 32, and how pitifully few are the distinct families of primitive groups we know or can reasonably hope to know.

The volume is very handsome. Paper and typography are all that could be desired, and the editing and proofreading is as near perfection as is humanly possible. As to misprints, it ties the present record of Lehmer's list of primes, as far as the reviewer was able to discover in an extensive but not complete reading.

W. A. MANNING

STANFORD UNIVERSITY

SPECIAL ARTICLES

THE ISOLATION OF A HOMOGENEOUS HEAVY PROTEIN FROM VIRUS-INDUCED RABBIT PAPILLOMAS

Two years ago[1] a crystalline protein was obtained by chemical treatment of the juice of plants diseased with tobacco mosaic virus. Numerous chemical, biological and physical experiments[2] indicate that this protein is the agent responsible for the disease. Similar chemical procedures have not yielded pure virus proteins from plants infected with other viruses. Recently, however, the development of methods involving differential ultracentrifugation has made possible the purification of proteins associated with the activity of certain of the less stable plant viruses.[3] The effectiveness of these methods has suggested the desirability of similar studies with animal viruses. The unusual stability of the virus causing infectious papillomatosis (Shope) recommends this agent as a favorable subject for such a study.

We have isolated from the virus-induced warty masses[4] from western cottontail rabbits a high molecular weight protein with which is associated the infectiousness of the disease. The following procedure has been adopted in preparing this protein. From 5 to 10 grams of glycerolated wart tissue known to be infectious were ground with sand and extracted with 100 cc of normal saline. After preliminary clarification by low-speed centrifugation extracts were ultracentrifuged[5] in 17 cc tubes for about two hours in a maximum field of 60,000 times gravity. The pellets thus thrown down were pooled and taken up in 7 cc of 0.1 M phosphate buffer solution, cleared of aggregated colloidal matter by low-speed centrifugation and again ultracentrifuged at 60,000 g to yield a pellet of heavy matter. This process was continued 3 to 4 times, or until tests with the analytical ultracentrifuge showed that all light-weight impurities had been lost in the supernatant fluids and all fine colloidal matter had been aggregated and eliminated through the intermediate low-speed centrifugations. Sixty grams of wart tissue derived from 5 different sets of warts were treated in this fashion. In 3 instances the papillomas were the result of "natural" infections; in the other 2 the growths had been induced by experimental inoculation. These tissues had different degrees of infectivity, suspensions of the most active producing rapidly growing papillomas in domestic rabbits 7 days after inoculation of saline extracts, the poorest requiring 13 days for the production of scattered warts.

Differential ultracentrifugation in each case provided a heavy protein free from colloidal impurities and detectable amounts of light-weight contaminants. A solution containing one mg per cc of this purified substance was opalescent and gave positive color reactions with the Millon, xanthoproteic and biuret reagents. A portion of the same solution failed to yield an immediate positive Molisch test for carbohydrate, but a faint violet ring of color developed on standing. The material was found to contain about 15 per cent. nitrogen by Kjeldahl analysis. The heavy protein is completely coagulated at a temperature of 66–67° C. and leaves a supernatant that is free of protein; the activity of papilloma extracts[6] begins to diminish at 67° C. and is completely destroyed at 70° C.

In the analytical ultracentrifuge the heavy protein from each sample sedimented with the sharp boundary that characterizes a single molecular species. In every instance the sedimentation constant was the same—

[1] W. M. Stanley, SCIENCE, 81: 644, 1935.

[2] W. M. Stanley, *Amer. Jour. Bot.*, 24: No. 2, 1937.

[3] W. M. Stanley and R. W. G. Wyckoff, SCIENCE, 85: 181, 1937.

[4] We are indebted to R. E. Shope of this Institute for the material used in this investigation.

[5] R. W. G. Wyckoff and J. B. Lagsdin, *Rev. Sci. Instr.*, 8: No. 3, 1937.

[6] R. E. Shope, *Jour. Exp. Med.*, 58: 607, 1933.

$S_{20°}$ = ca 250×10^{-13} cm. sec.$^{-1}$ dynes^{-1}. If this papilloma protein has about the same shape in solution as the tobacco mosaic virus protein molecule,[7] it will have a molecular weight somewhat in excess of 20,000,000; such a particle is about 40 millimicrons in diameter.

Practically the same yield (0.22 to 0.26 mgr per gram) of heavy protein was derived from all materials except one, which was notably richer (0.81 mgr per gram). In 3 experiments the effect of each centrifugation upon the infectious principle was determined. To do this, serial dilutions of the original saline extracts, supernatant fluids and solutions of the sedimented pellets were titrated in domestic rabbits.[8] The minimum amount of purified protein needed to produce warts visible 17 days after inoculation was between 10^{-7} and 10^{-8} grams, whereas between 10^{-5} and 10^{-6} grams of total protein in the saline extracts was required for comparable infection. The heavy protein was several thousand times as infectious as the wart tissue from which it was derived. These results show that there was no appreciable loss of viral activity at any point in the preparation, that it followed the heavy protein at every step and was concentrated with it.

There is other evidence that this protein is intimately associated with the viral activity. Active extracts of cottontail rabbit papillomas produce exuberant growths in domestic rabbits. These warty masses, however, usually yield no active virus.[9] We have subjected the extract from ten grams of domestic rabbit wart tissue, found in repeated tests by Shope to be non-infectious, to the ultracentrifugal concentration and analysis described above. No heavy protein was found.

We wish to express our indebtedness to W. M. Stanley for the invaluable advice he has given.

J. W. Beard
Ralph W. G. Wyckoff
The Rockefeller Institute for Medical Research, Princeton, N. J.

ACETYLATION OF PARA-AMINOBENZENESULFONAMIDE IN THE ANIMAL ORGANISM[1]

Para-aminobenzenesulfonamide has been shown to have a remarkable protective and curative action in β-hemolytic streptococcic infections in animals,[2,3,4,5] and is being used in the treatment of such infections in human beings. We became interested in studying the pharmacology of para-aminobenzenesulfonamide and have accumulated considerable data on its absorption and excretion. Quantitative determination can be made by diazotizing, coupling in acid solution with dimethyl-α-naphthylamine and comparing the color obtained with that obtained from standard solutions. With this method, we have shown that in the dog the substance appears to be excreted mainly or entirely in unchanged form, while in the rabbit and human it is excreted partly as a conjugated compound from which the original substance can be obtained by hydrolysis with dilute acid.[6] We present here data on the isolation and identification of a conjugated compound obtained from the urine of rabbits and humans after the administration of para-aminobenzenesulfonamide by mouth. We have also isolated the unchanged sulfonamide from the urine of dogs and humans.

A sample of urine obtained from a dog, which had received 1.0 gm per kgm of para-aminobenzenesulfonamide, deposited crystals on cooling in the ice box. These on recrystallization from dilute alcohol melted at 167–8°, a mixture with pure para-aminobenzenesulfonamide (M.P. 166–7°) melted at 167–8°. These crystals from the urine when analyzed by the colorimetric method checked a standard solution of the pure substance within 2 per cent.

A rabbit weighing 3.5 kgm received 3.5 gms of sulfonamide by mouth. Urine collected for the next 24 hours deposited crystals on standing over night. These were filtered off, recrystallized several times from water and dilute alcohol and finally from water. The final product consisted of beautiful needles melting sharply at 219°. Gelmo[7] gives the melting point of para-acetylbenzenesulfonamide as 219°.

Analysis:

Found N by micro-method 12.72 per cent.; 12.82 per cent.
Theoretical N for $CH_3CONHC_6H_4SO_2NH_2$ = 13.05 per cent.

Acetic acid was identified after hydrolysis as silver acetate, which was analyzed for silver with the following results.

[7] I. Eriksson-Quensel and T. Svedberg, *Jour. Am. Chem. Soc.*, 58: 1863, 1936; R. W. G. Wyckoff, J. Biscoe and W. M. Stanley, *Jour. Biol. Chem.*, 117: 57, 1937.

[8] J. G. Kidd, J. W. Beard and P. Rous, *Jour. Exp. Med.*, 64: 63, 1936.

[9] R. E. Shope, *Proc. Soc. Exp. Biol. and Med.*, 32: 830, 1935.

[1] This investigation has been aided by a grant from the Josiah Macy, Jr., Foundation.

[2] J. Tréfouël, Mme. J. Tréfouël, F. Nitti and D. Bovet, *Compt. rend. Soc. de biol.*, 120: 756, 1935.

[3] G. A. H. Buttle, W. H. Gray and D. Stephenson, *The Lancet*, 230: 1286, June 6, 1936.

[4] P. H. Long and E. Bliss, *Jour. Am. Med. Assoc.*, 108: 34, January 2, 1937.

[5] L. Colebrook, G. A. H. Buttle and R. A. Q. O'Meara, *The Lancet*, 231: 1323, December 5, 1936.

[6] E. K. Marshall, Jr., K. Emerson, Jr., and W. C. Cutting. In press. *Jour. Am. Med. Assoc.*, 1937.

[7] P. Gelmo, *Jour. für praktische Chemie*, 77: 369, 1908.

Found Ag = 63.4 per cent.
Theoretical for $C_7H_5O_2$ Ag = 64.04 per cent.

A solution of these crystals gave no color after diazotization on the addition of dimethyl-α-naphthylamine (no free NH_2-group on the benzene ring). After hydrolysis with dilute hydrochloric acid, the substance gave (by colorimetric method) 80.0 per cent. and 78.8 per cent. of para-aminobenzenesulfonamide. Theoretical for

$$CH_3CONHC_6H_4SO_2NH_2 = 80.3 \text{ per cent.}$$

The above data prove the conjugated compound obtained from rabbit's urine to be para-acetylaminobenzenesulfonamide.

This acetyl derivative has been obtained in several other experiments from the urine of rabbits given large doses of the sulfonamide. The following experiment gives a rough idea of the recovery.

A rabbit weighing 1.7 kgm received by mouth 1.7 gms of *para-aminobenzenesulfonamide.* Ninety cc of urine were secreted in the following 24 hours. This urine was heated just to boiling to dissolve a precipitate, and, while hot, 5 cc were taken and diluted for analysis. From this analysis the remaining 85 cc were calculated to contain 235 mgms of free para-aminobenzenesulfonamide and 1,010 mgms of the conjugated form (calculated as the acetyl compound). The 85 cc of urine were allowed to remain in the ice box for 2 days, the deposited crystals filtered off and dried. Six hundred mgms were obtained. On analysis, these crystals were found to contain 2 per cent. of free sulfonamide and 95 per cent. of the conjugated compound (calculated as the acetyl derivative). After three recrystallizations from water, the compound melted at 218°, and when mixed with para-acetylaminobenzenesulfonamide (the sample which had been identified) melted at 218°. The second 24-hour urine sample contained a considerable amount of the conjugated compound (by colorimetric analysis).

From the urine of a patient being treated with the sulfonamide para-acetylaminobenzenesulfonamide has been isolated and identified.

A 24-hour specimen of urine measured 980 cc. Analysis of a small sample showed it to contain 1.20 gm of free and 1.25 gm of conjugated compound (calculated as acetyl derivative). The urine was treated with 5 gms of charcoal (Norit), shaken and allowed to stand in the ice box for 8 days (a shorter time is sufficient). The charcoal was removed by filtration, and the filtrate analyzed. The filtrate contained 1.03 gm of the free and 0.25 gm of the conjugated compound. The charcoal was treated with 75 cc of 95 per cent. alcohol, heated for a few minutes on a water bath and allowed to stand over night. The charcoal was removed by filtration, the filtrate evaporated to about 15 cc, several volumes of hot water added and the solution placed in the ice box for 4 hours. The crystals obtained by filtration weighed 0.34 gm (dried at 100°). Colorimetric assay showed only a small trace of free sulfonamide, but after hydrolysis the sulfonamide content was increased to 77 per cent. The substance was nearly pure para-acetylaminobenzenesulfonamide. After solution of the 0.34 gm in hot alcohol, hot water was added and the solution was placed in the ice box over night. After recrystallization from water and drying at 90°, the needles melted at 219°, and a mixture of them with the acetyl compound from rabbit's urine melted at 219°. On the colorimetric assay after hydrolysis, the purified compound gave 80.6 per cent. para-aminobenzenesulfonamide, the theoretical being 80.3.

From the urine of another individual receiving the sulfonamide, both the unchanged sulfonamide and the acetyl derivatives were isolated in small amounts by evaporation and fractional crystallization and identified by mixed melting points. This method is laborious and was done before the selective adsorption of the acetyl derivative by charcoal was discovered.

We can conclude that in the rabbit and man the conjugated compound found in the urine after administration of para-aminobenzenesulfonamide by mouth is mainly, if not entirely, the acetylated derivative. It is interesting to note that this is another example of an aromatic compound containing an amino group attached to the benzene ring which the rabbit and man can acetylate but the dog can not.[8]

E. K. MARSHALL, JR.
W. C. CUTTING
KENDALL EMERSON, JR.
DEPARTMENT OF PHARMACOLOGY
AND EXPERIMENTAL THERAPEUTICS,
THE JOHNS HOPKINS UNIVERSITY

DIFFRACTION OF X-RAYS AT VERY SMALL ANGLES BY CELLULOSES AND RAYONS

FROM our laboratory have been reported already the measurements of very large spacings for a number of natural materials. These include 171 A.U. in living nerve,[1] 440 A.U. in collagen, 48 A.U. for radially oriented natural wax in intestinal wall collagen,[2] 81 A.U. in keratin, 58 A.U. in gel rubber and 75 A.U. in chitosan.[3]

By extending the experimental technique to its fullest possibilities, many attempts have been made to resolve interferences at very small angles corresponding to very large spacings in cellulose and its deriva-

[8] J. B. Muenzen, L. R. Cerecedo and C. P. Sherwin, *Jour. Biol. Chem.*, 67: 469, 1926.
[1] *Radiology*, 25: 131, 1935.
[2] *Radiology*, 27: 339, 1936.
[3] *Jour. Am. Chem. Soc.*, 57: 1509, 1935; *Jour. Phys. Chem.*, 40: 863, 1935.

tives. In most of these cases there is a definite but somewhat diffuse scattering at very small angles. Equatorial maxima run out from this halo like small arrowheads, but in spite of ingenuity in obtaining the very sharpest possible patterns, it has been impossible to resolve these equatorial streaks into a series of individual spots. There are, however, some very interesting characteristics of this phenomenon which seem worth recording.

Fig. 1*a* is a diagrammatic representation of the

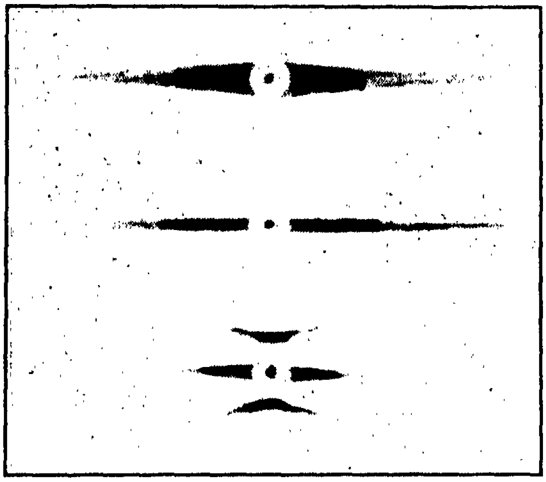

FIG. 1. Diagrams of diffraction effects at very small angles of fiber pattern. (*a*) Native ramie. (*b*) Mercerized ramie dried under tension. (*c*) Regenerated cellulose rayons (nitro, cuprammonium, viscose).

innermost part of a diffraction pattern for native ramie. A continuous streak runs along the equator from the central spot of the pattern, which is widest at the smallest angles and tapers gradually to a nearly constant width of blackening on the film. The greatest intensity seems to be reached at a spacing of about 40 A.U., followed by a rapidly diminishing intensity down to about 20 A.U. The obvious explanation of this pattern seems to be that a whole range of lateral spacings between macromolecules, crystallites or micelles occurs. The greater this spacing is, that is, the smaller the angle, the less perfect is the longitudinal arrangement along the length of the chains in the crystallites so that the resulting diffraction effect is increasingly more diffuse or wider.

In Fig. 1*b* is represented the innermost part of the pattern of mercerized cellulose dried under tension so that the greatest preferred orientation can be gained. The same equatorial streak can be observed as with the original native ramie, but now it is very sharp and uniform in width until it merges with the trace of the undiffracted beam. The marked effect, therefore, of pulling the chains more nearly parallel to each other is directly indicated.

Fig. 1*c* represents an entirely new finding for rayon. With the most careful technique involving very small pinholes, careful blocking of the primary beam, vacuum camera and similar details, we find for all regenerated cellulose rayons, including nitro, cuprammonium and viscose, the production of a very sharp equatorial streak and very definitely a first layer line on either side from which can be measured a fiber identity period of 154 A.U. Acetate rayons do not give this pattern but only a fairly diffuse general scattering around the central spot. The progression in regularity of structure from native ramie to mercerized ramie when dried under tension and then to commercial rayons seems to be clearly indicated by these curious unresolved diffraction maxima at very small angles.

G. L. CLARK
E. A. PARKER

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF ILLINOIS

SECONDARY INCREASE OF LENGTH OF STRETCHED CHILLED RUBBER[1]

DURING some work on "frozen" crude rubber, we have noted that stretched samples behave in a curious way that may have significance in attempts at explaining the rubbery state.

It is well known that crude rubber becomes hard and opaque at low temperatures, and is then said to be "frozen" or "boardy." It exhibits most of the phenomena associated with true crystallization; for instance, a development of well-marked, strongly birefringent granules, a decrease in volume during freezing and an incipient formation of crystal nuclei at a low temperature before contraction in volume begins.

In the current investigation we have noted the following strange behavior of crystallizing samples. When a piece of crude rubber, for example, a strip about 5 mm wide and 2 mm thick, is stretched moderately, cooled to $-25°$ C. and maintained at that temperature, it first becomes hard and then during a few hours the length of the stretched piece increases about 4 per cent. A strip of rubber, stretched and nailed to a board, rises to form an arc between the points of attachment. This secondary elongation is roughly independent of the amount of stretch if the increase in length has been between 20 and 300 per cent. We have observed it with smoked sheet, pale crepe, milled pale crepe and with smoked sheet that has been swelled slightly by benzene to remove strains, and thoroughly dried. It is absent or feeble with vulcanized rubber

[1] Publication approved by the director of the National Bureau of Standards of the U. S. Department of Commerce.

or with rubber that has been stretched to the degree at which it displays marked resistance to further elongation. The elongation does not occur with unstretched rubber. The effect is not simply a component of the volume changes which occur on stretching or freezing, but is opposite in direction and has at least four times the magnitude which such volume changes would produce. Measurements have not yet been made of the change of volume accompanying the elongation. By analogy with the contraction of stretched rubber on heating, it seems probable that this phenomenon is related to the Gough-Joule effect, and that the increase in length is accompanied by a lateral contraction of such magnitude that the volume decreases.

Available evidence indicates that rubber hydrocarbon consists of very long molecules. When rubber is stretched, these molecules tend to be oriented parallel to the direction of elongation, so that, when freezing begins, a crystalline axis has already been established. The crystals are correspondingly oriented. During freezing a time comes when enough molecules have fallen into crystalline spacing to harden the sample and relieve the stresses that produced stretching. As more molecules move into the crystalline arrangement, the spacings at right angles to the stretch become less, the long directions of the molecules become more strictly parallel to the axis of stretch, and the sample is elongated. This explanation is supported by unpublished evidence regarding crystal growth at approximately $-25°$ C.

W. Harold Smith
Charles Proffer Saylor
National Bureau of Standards

SCIENTIFIC APPARATUS AND LABORATORY METHODS

POTENTIAL MEASUREMENTS IN OXIDO-REDUCTION MIXTURES[1]

In the series "Studies on Oxidation-Reduction,"[2] Clark has described the apparatus used for potential measurements of oxido-reduction dyes in various ratios of oxidant and reductant. The mounting of the potentiometer and the gas purification being left out of consideration, the principle of this apparatus is briefly the following.

Reductant is sucked out of the reduction vessel into a reservoir. Here the hydrogen gas still present is removed from the reductant by passing nitrogen through it. Now a burette may be filled from the reservoir, so that measured quantities of reductant may be introduced into the electrode vessel. We then found that this apparatus might quite well be simplified, while retaining the principle according to Clark, by leaving out the reservoir and substituting the burette for it. At the same time the number of taps is in this way reduced from 6 to 3, as is apparent from the figure (Fig. 1). During the numerous determinations of oxido-reduction curves executed with this apparatus, it has continually proved to answer the purpose easily. This may justify this short communication.

The apparatus is used in the following manner: Via A, three-forked tap X (T shape) and B the electrode vessel C may be made free from oxygen by passing nitrogen through it. *Via* G and three-forked tap Y the nitrogen may be led through burette D and then either to the electrode vessel (*via* three-forked tap Z with double boring) or to the reduction vessel M, first

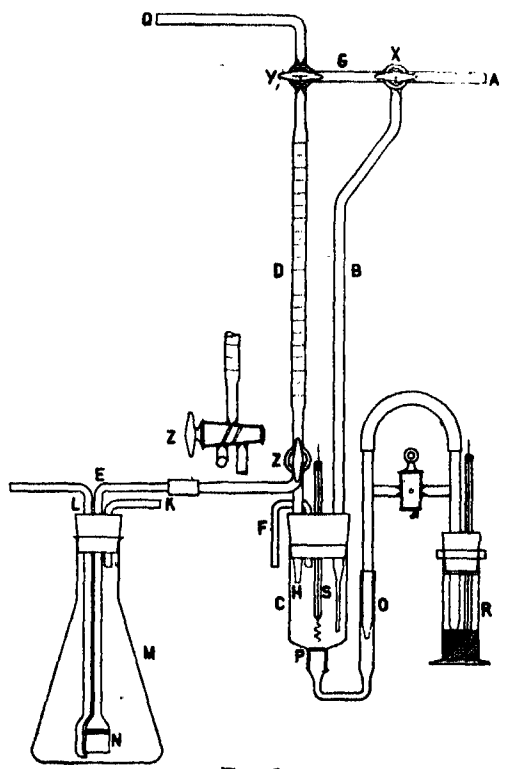

Fig. 1

driving away the oxygen and after reduction the hydrogen. The stream of hydrogen passes to M *via* L. By connecting Q with a water spout air pump, the reductant may directly be sucked into burette D, after being freed from hydrogen in the reduction vessel. This takes place under overpressure of nitrogen in M *via* a tube of communication with L which has not been drawn in the figure. After the burette has been filled,

[1] From the Histological Laboratory of the University of Amsterdam. Director, Professor Dr. G. C. Heringa.

[2] No. 3, pp. 31–36, U. S. Government Printing Office, Washington, 1928.

the stream of nitrogen is again led *via* A to D, so that the vacuum above the reductant is filled with nitrogen. By means of tap Z an accurately measured quantity of reductant may then be added to the oxidant in the electrode vessel. As a rule 9 cc. of the oxidant was brought into the electrode vessel and to this was added 1, 1.25, 1.60, 2.15, 3, 4.5, 7.5, 15 and 45 cc., respectively, of the reductant. Thus the ratios oxidant: reductant were gone through from 9:1 to 1:9. Likewise for the measurement of oxido-reduction curves with solutions of reducing salts this apparatus is very useful.

D. B. Kroon

MUSEUM LABELS

Regarding the suggestion of Professor Tolmachoff in Science of November 20, concerning an enamel patch and lettering system for museum labels, perhaps a simplified variation may also be of interest. Instead of ordinary gloss enamel, use is made of one of the modern lacquers such as white Duco. This not only has the advantage of rapid drying but has a surface which will take India drawing ink used with a steel pen. The inconvenience of cleaning a brush can be avoided by applying the white finish with a toothpick of the ordinary type which is flat at one end. After a little practice, a patch can thus be made as neatly as with a brush. The average operator will find it a great advantage to be able to do the lettering with a pen instead of a brush. It is even possible to dispense with a stirring paddle by merely keeping the can less than two thirds full and vigorously shaking before each occasion of use. For infrequent but busy occasions, this method of preparing labels is ideal, and during two years of use it has given all the satisfaction that could be desired.

Clarence R. Smith

Aurora College

THE FLAGELLA OF PERANEMA

Due to the fact that there still remains considerable doubt in the minds of some investigators (Hyman, 1936)[1] concerning the existence of a second flagellum in *Peranema trichophorum,* it seems advisable to suggest a procedure by which this structure in the living organism can be demonstrated.

Korschikow (1924)[2] stated that weak solutions of gentian violet stain would cause the second flagellum, which is adherent to the periplast, to be loosened and to extend away from the cell because of the increase in metabolic movements of the organism. I have used a 0.02 per cent. concentration by weight of this stain and have obtained excellent results by the addition of equal parts of the stain and culture medium on a slide. A cover slip was used and the resultant solution examined at once with a 4 mm objective. The peranemas which come into contact with the stain become very metabolic and, in many cases, after a short interval, the second flagellum is visible projecting from the anterior end of the animal.

Students in protozoology at Ohio State University have used this procedure repeatedly in classroom work and the stain has proved to be effective in approximately half the cases.

D. W. Dunham

Ohio State University

[1] Libbie H. Hyman, *Quart. Jour. of Micros. Sci.*, 79: 43–56.

[2] A. A. Korschikow, *Arch. russ. Protist.*, 3: 148–205.

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Ford, Walter B. *A First Course in the Differential and Integral Calculus.* Revised edition. Pp. vii + 369. 168 figures. Holt. $3.00.

Gurney, R. W. *Ions in Solution.* Pp. vi + 206. 45 figures. Cambridge University Press, Macmillan. $3.00.

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THE HISTORY AND WORK OF THE ARMY MEDICAL LIBRARY[1]

By Lieutenant Colonel EDGAR ERSKINE HUME

MEDICAL CORPS, U. S. ARMY, MEDICAL FIELD SERVICE SCHOOL, CARLISLE, PA.

THE celebration on November 16, 1936, of the centenary of the foundation of the Army Medical Library served to bring home to a large number of persons not engaged in work in the medical sciences the importance of this great collection of books. This celebration was attended by six or seven hundred representatives of universities, libraries and learned societies of the world, and cablegrams, letters and diplomas of honor were received from nearly 200 foreign institutions alone. These bodies joined in commemorating the establishment of what is now the largest collection of medical literature that the world has ever seen. The development of this mighty library in so short a time is a phenomenon in which American science and letters may take pride.

Established in 1836 by Surgeon General Lovell as a small number of reference medical texts for the use of his staff, it was in fact as well as in name "The Surgeon General's Library." The collection, hardly more extensive for some years than President Eliot's five-foot shelf of books, grew but slowly until, at the close of the Civil War, one of the greatest men of science our land has produced was placed in charge and given the congenial task of building up a great national medical library.

This man was Surgeon John Shaw Billings (1838–1913). When he took up his new work the library consisted only of 2,253 volumes (602 titles under 11 topical subdivisions). A catalogue of the collection was printed in 1865. Billings was given the sum of $80,000 left over from the hospital fund of the war, and wise Surgeon General Barnes likewise gave him a free hand. Billings had realized the need for such a library ever since he was a medical student at what is now the University of Cincinnati. Writing many years later he said:

[1] Read on December 30, 1936, at Brown University, Providence, R. I., before the joint session of the History of Science Society and the American Historical Association.

I became convinced of three things. The first was, that it involves a vast amount of time and labor to search through a thousand volumes of medical books and journals for items on a particular subject, and that the indexes of such books and journals can not always be relied on as a guide of their contents. The second is that there are in existence, somewhere, over 100,000 volumes of such medical books and journals, not counting pamphlets and reprints. And the third was, that while there was nowhere in the world a library which contained all medical literature, there was not in the United States any fairly good medical library, one in which a student might hope to find a large part of the literature relating to any medical subject, and that if one wished to do good bibliographical work to verify references given by European medical writers, or to make reasonably sure that one had before him all that had been seen or done by previous observers or experimenters on a given subject he must go to Europe and visit, not merely one, but several of the great capital cities in order to accomplish his desire.

With a gift for judging the value of books, an almost uncanny sense of where to find them and an orderly mind that enabled him properly to classify them, Billings was equipped by nature to be America's greatest bibliographer. He worked with extraordinary energy. In 1871 he produced his first catalogue, a three-volume work, each volume of the approximate size of the present Index Catalogue. But it was a catalogue only, and not comparable with the Index Catalogue soon to follow.

"Books," said Billings, "are properly compared to tools, of which the index is the handle." He had to have such a handle for his collection, already becoming unwieldy. So, in 1876, he published a "Specimen Fasciculus of a Catalogue of the National Medical Library, under the Direction of the Surgeon General, United States Army." This he submitted to the medical profession for criticisms and suggestions. Its style and arrangement were practically that of the Index Catalogue itself, another evidence of Billings's skill. Finally Congress was induced to appropriate funds for the publication of the work, and the first volume appeared in 1880.

Since such matters as typography and general arrangement of the contents had been settled in the "Specimen Fasciculus," there remained only the question of classification to be decided. "Following the general idea of a subject and author catalogue arranged in dictionary order in a single alphabet, the special subjects were featured by means of key titles or rubrics. After settling upon the main grand divisions, such as *Aneurism, Cancer, Tumors,* etc., and subdividing these, the subjects of lesser weight easily fell into their places by the simple device of finding the centers of gravity of the title in each case."[2]

[2] Garrison.

Dr. Billings saw clearly that he could not prepare a complete bibliography of his subject, but rather a bibliographical conspectus of the contents of a great library. Happily this proved so complete that it became, for practical use, a working bibliography of medicine. Modern medical science was even then beginning to advance by leaps and bounds, its surface aspect constantly changing as it advanced, so that he saw at once that it would be impossible to adopt any arbitrary and fixed classification based on a definite scheme of nosology. Any such scheme would have been, like the average medical text-book of to-day, obsolete within a few years.

The appearance of the Index Catalogue marked an epoch in the development and improvement of medical literature, particularly in the United States. For the first time the literature was at hand in the most convenient and accessible form, that is, strictly alphabetically catalogued. The Index Catalogue has no equal. "Its preparation," said Osler, "is Gargantuan." In no other field of knowledge is there a work comparable to this, the world's standard of medical bibliography. No matter where medical research is undertaken, there must one have the Index Catalogue. It is as much used in Europe, Asia and South America as in our own continent. "Among catalogues," says Professor William Bulloch, F.R.S., "it is regarded by the authorities of the British Museum as the greatest ever achieved."

The First Series of the Index Catalogue, 16 volumes, was completed in 1895 with the end of the alphabet, and Billings retired to accept the chair of hygiene at the University of Pennsylvania. Subsequently he was given charge of the consolidation of the three public libraries of New York City and the cataloguing of each, becoming, when the present building was completed, its librarian. A Second Series of the catalogue was begun in 1896 under the careful redaction of Billings's assistant, Dr. Robert Fletcher (1823–1912). This (26 volumes) was finished in 1916 and the Third Series of 10 volumes appeared between 1918 and 1932. The first volume of the Fourth Series was issued last spring and the second volume is now in press.

In 1879 Billings established another monumental work, the Index Medicus, a monthly classified record of the current medical literature of the world. The editorial management of the Index Medicus was principally in the hands of Dr. Fletcher, likewise a noted bibliographer. The Index Medicus consisted, from the start, of a printed monthly fasciculus, giving the medical literature of the preceding month carefully arranged as to subject-rubrics. The classification, as covering a smaller body of material, was more general than that of the Index Catalogue.

Never a government publication, the Index Medicus

always had great difficulty in paying for itself. It was expensive to publish and, though of the greatest use, the number of subscribers was necessarily limited, being chiefly medical libraries. From 1879 to 1899 it was published successively in New York, Detroit, Boston and Washington. Finally its founders could no longer afford to continue it. In vain did such men as Osler and Weir Mitchell plead with physicians to subscribe. In Paris Professors Charles Richet and Marcel Baudoin issued Bibliographia Medica (3 volumes) from 1900 to 1902 as a replacement, but they too had to give up. In 1903 the Carnegie Institution of Washington took over the Index Medicus and carried its financial losses until 1927, when the Index Medicus was merged with the Quarterly Cumulative Index (founded 1916) of the American Medical Association. The combined periodical, the Quarterly Cumulative Index Medicus, was published under the joint direction of the Army Medical Library and the American Medical Association until the end of 1931, when its connection with the library ceased, and it became solely a journal of the association. Except for two years spent in Manila, Dr. Fielding Hudson Garrison (1870–1935) was the editor of the Index Medicus after it was taken over by the Carnegie Institution.

With two such working tools as the Index Catalogue and the Index Medicus the student of medical science can in a very few moments assemble the bibliography of a subject or an author. Each series of the Catalogue includes the complete alphabet from A to Z. Thus he merely looks in each for the subject or author of his choice and notes what the library has about or by each man. From the date of the volume of the last series to the present, the annual volume of the Index Medicus are consulted and so it is a simple matter to complete the bibliography. Each day the cards of the Army Medical Library are brought up to date so that the cataloguing of journal articles is done within a short time of their receipt. The library is glad to quote the cards that have accumulated since the last issue of the Index Medicus thus rendering a bibliography as complete as can be.

This is not the place to recount the struggles that the library has had to obtain suitable quarters. The building now in use was erected in 1887 and was then adequate, but rapidly growing institutions, particularly libraries, have a way of outgrowing their garments, so that now the building is so overcrowded that the stacks will bear no more weight. The engineers require that when books are added others be withdrawn, so that the overflow fills the cellar and garret, and every other nook and corner. A new building must soon be provided, and this, we hope, will be of such size and construction as to provide for expansion. Tentative plans have been drawn, and the century-old institution now but awaits Congressional consideration to provide the necessary funds—so small in these days of great financial figures.

A word as to the manner in which the Army Medical Library functions. It seeks, and its efforts have been crowned with no small success, to obtain everything worth while that is published anywhere in medical science. It receives an appropriation for purchases amounting to $20,000 per year, more or less, for Congress is at times more liberal than at others. All this goes into the acquisition of books and journals. Many authors and many institutions have long made it a practice to present a copy of each of their publications to the Army Medical Library, thus insuring their inclusion in the Index Catalogue. American law requires that two copies of each book copyrighted be sent to the Copyright Office, and one of these is preserved in the Library of Congress, while the other is, usually, turned over to some other governmental library. Most of these second copies of medical works are given to the Army Medical Library, though of late there has been a tendency for the Library of Congress to retain both copies of many purely medical works. Many institutions, receiving the Index Catalogue as a gift, reciprocate with gifts of their publications. So the $20,000 goes much further than would otherwise be possible. Moreover this sum does not have to cover such necessary expenses as salaries of personnel, postage, transportation costs, binding, etc. Thus it is possible for the library to receive upwards of 2,000 medical journals, the largest number of any medical library in the world.

All the books and practically all the material in the journals are indexed by subjects (the books by authors as well) and these entries soon make their appearance in the Index Catalogue. The material is available not only to local readers, but through the inter-library loan system to every student, physician and other reader in the country. So great has this inter-library loan department grown that now the library maintains its own mail wagon. Canada, too, benefits from this arrangement, and McGill University is one of the library's largest borrowers.

Everything in the library is available on loan except the rare material or what is unbound. The library's collection of rare medical books is one of the best in the world, and by far the best in America. It has an unusually complete statistical collection, the growth of about thirteen years and supplementing the splendid collection presented by the Prudential Life Insurance Company in 1923. There are medical manuscripts of great worth from the earliest day to the present. The document collection is, probably, the most complete of its kind.

The growth of this great collection of medical literature well illustrates the advantage of allowing a specialized library to develop along its own lines, without being hampered as must otherwise be the case, if merely a department of a great general library. The contrast between the national medical and law libraries well illustrates this. The Law Library of Congress was established in 1832, Congress requiring that it be maintained as a separate unit in "an apartment near the Library of Congress." This collection has frequently been neglected and has received but little money. Several law libraries in the United States are superior to the Law Library of Congress in some fields, while the Harvard Law Library is far larger and superior in every way, containing (1933) 435,000 volumes to the 275,000 of the Law Library of Congress. Contrast this with the growth of the Army Medical Library, which in twenty years passed the medical collections of the two largest general libraries in Europe, as well as those of America. "Undoubtedly," wrote the Law Librarian of Congress in 1933, "had the Law Library been independent from its foundation in 1832, the government would have possessed the best law library in the world to-day, instead of lagging behind, with many serious gaps in the collection." He therefore urged the friends of the Law Library of Congress to crystalize sentiment through the country to aid the Law Library to become as eminent in law as the Surgeon General's Library is in medicine.

In Europe one sees the disadvantages of merging a specialized library in a general collection. Billings himself always stressed this and showed that neither the medical collections of the Bibliothèque Nationale de France nor that of the British Museum has been able to develop as would otherwise have been possible. Medical writers make comparatively little use of these collections, preferring to use the special medical libraries of London and Paris, which are under the direction of medical bibliographers. I mention all this because from time to time one hears the suggestion that the Army Medical Library be added to the Library of Congress. The librarian of Congress, Dr. Putnam, recognizes the disadvantages of such a consolidation, adding that the Army Medical Library should "be administered by those familiar with that field."

I have sometimes thought that medical writers and students of the medical sciences in general are, bibliographically speaking, divided into two classes, those who know the Army Medical Library well, and those who do not know it at all. There are no half tones. Such folk are either in the high lights or the shadows, as it were. Those in other fields of learning may, perhaps far oftener than they may think, find material to their tastes and interests in this mighty collection of a million items. Its Index Catalogue is a tool that many other hands than those of physicians may use to good effect. It should be of interest to all men of letters, as well as of science, to know how to use a work which indexes practically everything of value in medical science, including every worthwhile article in every issue of every journal of every country in every language. Then, if not before, does one come to appreciate the soundness of dictum of the late Dr. William H. Welch, that the "Army Medical Library and its Index Catalogue are America's greatest gift to medicine."[8]

[8] The discussion of this paper was opened by Dr. Arnold C. Klebs, of Nyon, Switzerland, who said: "To us of the older generation who were privileged to visit under the inspiring guidance of Osler, when Billings, Fletcher and Garrison were still there, this great institution which later was so sympathetically and efficiently presided over by Colonel Hume, his report of past achievements and future problems makes a singular appeal. Does the present generation fully realize that we have there much more than a mere collection of books for use of the medical officers of the Army, much more even than a National Medical Library? In my wanderings abroad through numerous libraries I have always made it a point to ask the librarians how they advised those that were preparing medical monographs in the gathering of relevant material. The answer was invariably that the Index Catalogue was first consulted and often supplied all that was wanted. And when we consider that these rows of green books did not only grace the shelves by the side of the tomes of

WAVES AND CORPUSCLES IN QUANTUM PHYSICS[1]

By ALFRED LANDÉ
OHIO STATE UNIVERSITY

It is a well-known fact that macroscopic phenomena, like the reflection, refraction, diffraction and the propagation along curved paths of matter and light rays, can be described by means of the corpuscular theory as well as by means of the wave theory. As to microscopic phenomena of atomic dimensions, one can apply the two classical models only to a certain degree, the limits of the corpuscular description being drawn by the Heisenberg uncertainty principle. Nevertheless, many physicists seem to prefer the corpuscular picture when they are asked as to what is happening "in reality."

Take for instance the usual statistical *corpuscular interpretation of Schrödinger's wave function* ψ; here $|\psi|^2 = \rho$ is said to mean in reality the probability density of particles in space. To make this statistical distribution possible one has afterwards to resort to

[1] Address given at the Ohio Physics Club in Cincinnati, December, 1936.

rather artificial additional hypotheses. One has to endow the particles with a mysterious power of preferring regions where associated waves have their intensity maxima, in contradiction to the causal laws of mechanics. Sometimes the ψ-function seems to direct the particles even to regions where their kinetic energy would be negative and their velocity imaginary. On the other hand, one often applies a *wave interpretation of corpuscular phenomena:* It is said that the vibrational energy of matter or light waves within a vessel is confined to certain quantized levels, in contradiction to the continuous process of damping asked for by the wave theory.

I want to show here that these apparent contradictions are not at all inherent features of quantum theory, but are entirely the result of uncritical over-interpretations of the observed facts. Quantum theory in the contrary is based on the fundamental *complementarity* of waves and corpuscles, neither of them having a preference over the other, but either one describing the observed facts consistently without contradictions, as long as we confine ourselves to describing what we see. In order to become more critical towards a customary statement about the "real" nature of an observed process it is a good policy to compare the statement with a complementary statement in which the rôle of waves and corpuscles has been interchanged. If the antithesis obtained in this way proves to be unsatisfactory, then the original thesis ought to be considered as questionable, too. We are then better prepared to criticize both of them.

Let us recall that the general theory of relativity, too, started from a twofold interpretation of physical facts. The motion of a stone can be explained in two equivalent ways, either by the assumption of a field of gravity, or by reference to an accelerated system of coordinates. It would be quite a mistake, however, and contrary to the basic idea of relativity to apply the two explanations simultaneously and to ask, for instance, for the seat of gravitational forces *within* the accelerated frame. But it is just this kind of over-interpretation that can be found in the corpuscular interpretation of Schrödinger's wave function as well as in the aforementioned wave interpretation of selected energy levels.

Let us take the example of a *linear harmonic oscillator.* A piece of matter can be said to consist of microscopic oscillators if we observe it reacting *as though* it consisted of such oscillators. We might, for instance, illuminate the piece of matter with light waves of a given frequency ν. If the transmitted light shows, beside the original color ν, the new colors $\nu + \nu_o$ and $\nu - \nu_o$ (Raman-effect), and if, beside the original ray, a bundle of new diffracted light waves is emerging, then we may explain this effect in two independent ways, without contradictions.

(*a*) According to the wave theory of light, the color effect is produced by resonating matter which has a proper frequency ν_o. And the angular diffraction is explained by a certain continuous distribution of the resonating matter in space forming a cloud of density ρ_o that serves as a Huyghens source of the secondary radiation $\nu \pm \nu_o$.

(*b*) The same optical effect of color change and diffraction can secondly be interpreted in corpuscular terms. The light is then supposed to consist of photons of energy E and of momentum P. The color effect indicates that the resonating matter consists of particles which exchange energy amounts E_o with the photons so that the latter emerge with energies $E + E_o$ and $E - E_o$. Furthermore, the matter particles transmit momentum to the photons P and deflect them from their original direction. An analysis of the angular intensity distribution of the diffracted photons would tell us now how many particles have the momentum p and how many have the other momenta $p', p'' \cdots$, assuming that matter particles change their momentum from p' to p'' with a probability proportional to the product $\sigma(p') \cdot \sigma(p'')$, where $\sigma(p)$ is the *abundance* of various momenta p in the assembly of particles.

Either explanation is self-consistent. But it would be unreasonable to fuse them into one inconsistent idea. If we receive an optical signal reading "Camels," we can interpret it consistently in two ways. Either we assume the signal to come from a Bedouin in the desert, or from a smoker of cigarettes in America. But nobody would reasonably infer that the sender is an American smoker who is located in the desert. Likewise, it is unreasonable to infer that the matter particles which were introduced as the hypothetical source of corpuscular transmissions of energy $\pm E_o$ (first interpretation of the signal) are located in space in a manner described by the vibrating density ρ_o (second interpretation). Nor would it be sensible to assume that the resonating wave density ρ_o which was introduced as the hypothetical source of a wave radiation $\nu \pm \nu_o$ (second interpretation) changes its vibrational energy suddenly by such amounts E_o as were introduced in order to explain the optical effect in a corpuscular way (first interpretation).

Over-interpretations like this and the attempts to fuse contradictory ideas have become the source of

the old classical bibliographers such as Gesner and Haller in European lands, but extended into the Far East and Far South, we could not resist a feeling of pride and warm admiration for the organizing genius of Billings, the fastidious classifier that was Fletcher, and the historical sensibilities of a Garrison, who had created an instrument of such far-reaching potentiality. Truly if there is one unifying emotion capable of bringing together a much split-up profession it might be aroused by this great achievement and its continuance in the future.''

many difficulties that have worried the students of quantum theory. This applies, for instance, to the *apparent failure of causality* in microphysics. A train of parallel light passing a small disk of microscopic dimensions (we could just as well use our former example of an oscillator) chooses to diffract its photons through a bundle of directions as though the photons had knowledge of the interference rules of waves. The photons, instead of going straight ahead, disregard the laws of causality and follow the guidance of a wave function; this is the current opinion. The paradox and its philosophical consequences disappear, however, if we describe the diffraction by a disk (or oscillator) consistently in pure wave or in pure corpuscular terms. The wave theory of light considers the disk of radius r as the Huyghens source of secondary waves. The density function of the disk is $\rho \begin{Bmatrix} = \text{const. inside} \\ = 0 \text{ outside} \end{Bmatrix}$ of the radius r. The corpuscular theory explains the same phenomenon by means of photons of momentum P. It then has to describe the disk in corpuscular terms as well. Instead of having the density $\rho(r)$ as the Huyghens source of waves, the disk is now to be represented as an assembly of particles, in which various momenta p are present with an abundance $\sigma(p)$. The diffraction is explained by collisions between the photons and the matter particles which exchange their energies and momenta according to the causal conservation laws of mechanics, the number of transitions of the matter particles from p' to p'' being proportional to $\sigma(p') \cdot \sigma(p'')$. In the wave description disks of various shapes and sizes differ by their density distribution $\rho(r)$. From the corpuscular point of view various disks differ with respect to their spectrum $\sigma(p)$ (abundance function) of momenta. But it would be a violation of the basic idea of quantum theory to say that particles of matter with their distribution of momenta $\sigma(p)$ are located preferably in the maxima of the density function $\rho(r)$, the latter having been introduced only for explaining the diffraction from the wave point of view. Nor would it be reasonable to say that the matter waves which give rise to the aforementioned wave density $\rho(r)$, change their momenta and energies in such finite steps as were postulated in the corpuscular interpretation.

In contrast to the two independent interpretations of the "Camel message," however, the two interpretations $\rho(r)$ and $\sigma(p)$ of the optical message are mathematically dependent. The purpose of quantum theory is to find the mathematical rules for calculating the density function ρ when its complementary abundance function σ of the momenta is given, and *vice versa*. In fact, quantum theory gives direct mathematical relations between the density *amplitude* $\psi(r)$ and the abundance *amplitude* $\chi(p)$ whose absolute squares are $|\psi|^2 = \rho$, $|\chi|^2 = \sigma$. In the case of free particles (plane waves) each is a Fourier expansion of the other:

$$\psi(r) = \int \chi(p) \cdot e^{\frac{2i\pi}{h}(p \cdot r)} \, dp \text{ and its inversion.}$$

$$\chi(p) = \frac{1}{h} \int \psi(r) \cdot e^{\frac{-2i\pi}{h}(p \cdot r)} \, dr$$

But are there not many instances where the corpuscular interpretation of the ψ-function actually works in spite of the objections raised above? Indeed, the corpuscular interpretation of ψ works in describing *macroscopic* observations, for instance, in describing the structure of an interference pattern on a screen. The wave function ψ of the light amplitude predicts the time average of the intensity distribution on the screen with its maxima and minima; but the enumerable scintillations observed on the screen at low intensity comply indeed with the corpuscular interpretation of ψ. All this holds, however, only to a very limited extent. It is true that far away from the microscopic sources, in regions of small curvature, both the corpuscular and the wave theory are capable of explaining the macroscopic distribution of intensity—as far as *averages* in time are concerned. The relative fluctuations of the intensity, however, depend on the absolute magnitude of the intensity. Only if the latter is small is it true that one obtains relative fluctuations *as though* the ray consisted of a shower of particles, namely, scintillations and sudden registrations of Geiger counters. At large absolute intensity, however, one finds fluctuations of a quite different type known as interference fluctuations, as though the ray consisted of waves.

It is only because both classical theories are capable of describing *averages* of the intensity that one can proceed in the following two ways. (1) Calculate the average intensity by means of the wave theory (ψ-function); then, if its absolute value is small, calculate its fluctuations in a corpuscular way. This calculation gives then the impression as though the wave function ψ were "in reality" only a probability amplitude for particles. (2) Or proceed as follows: Calculate the average intensity by means of the corpuscular theory; then, if the absolute value of the intensity is large, calculate its fluctuations from interferences of waves. This calculation suggests, then, to consider the rays as consisting "in reality" of waves. How fallacious it is to believe in either of these interpretations is seen from the fact that at intermediate intensities the fluctuations follow a law which is neither corpuscular nor wave-like but is a compromise between both of them (Einstein's fluctuation formula).

I hope to have shown in the first part of these considerations that the usual corpuscular interpretation of Schrödinger's ψ-function rests upon an unjustified overinterpretation of the observed facts, in contrast to the basic idea of quantum theory, which is the idea of complementarity. In the second part I tried to point out that, although the corpuscular interpretation is working in the case of small intensities, it represents only a very limited point of view in describing what is observed in reality.

OBITUARY

SARA GWENDOLEN ANDREWS

On December 13, 1936, there passed away a woman with the rare gift of genius, Mrs. Ethan Allen Andrews, the wife of Professor E. A. Andrews, of Johns Hopkins. Mrs. Andrews, born Sara Gwendolen Foulke, died suddenly of a heart attack at her home in Baltimore. She had lived a retired life for years and many biologists in recalling her personally must go back to the memory of the beautiful, gracious young woman who made such a charming figure in the Woods Hole circle of the early 1890's.

Mrs. Andrews was born at Bala Farm in Pennsylvania in 1863. She studied at private schools and later for a time at Bryn Mawr, the University of Pennsylvania, Woods Hole and Roscoff on the French coast. She was married to Professor Andrews in 1894. Her earlier investigations dealt with infusoria and rotifers, but she became deeply interested in the structure and habits of protoplasm in general. And this is the theme of her classic memoir, "The Living Substance as Such: and as Organism," published as a special supplement of the *Journal of Morphology* in 1897, a memoir which carried her name and aroused admiration in biological circles throughout the world.

"The Living Substance" is not a paper with a definite contribution of fact or relationship between facts to be laid away after its essence has been incorporated in the handbooks. It is that and more. It has both depth and a grasp of many ideas. And one can read to advantage and with pleasure to-day this record of the multifarious experiences of a very thoughtful mind and a remarkable pair of eyes, aided by the best microscopic equipment of the time, in an exploration of the appearance and behavior of living protoplasm in protozoa, myxomycetes, leucocytes of invertebrates, sea-urchin and starfish embryos, fish eggs and other things.

The living substance, because of its tendency to take up water, exhibits itself to us as a Bütschli-structure, having the form of an emulsion, but it is only the continuous substance, separating and surrounding the droplets of included material, water and other things, that is alive. This is constantly active and its behavior is pictured as leading to changes in the general appearance of protoplasm. The alveoli, containing the discontinuous non-living stuffs, are increased or diminished in size or rearranged with the production of thin membranes, pellicles, within a protoplasmic mass or at its surface, constituting in the latter location a cell membrane. The thin lamellae between the alveoli may burst and disappear or their substance may "crawl or flow away," thinning and breaking in places and thickening elsewhere, or it may flow out at the surface of the mass or into the alveoli in the shape of delicate filose pseudopods forming in some cases new lamellae, one series of such changes in what Martin Heidenhain ("Plasma und Zelle," 1907) has called the architectural structure of cytoplasm culminating in cell division.

The histological section of this notable work is followed by a survey of the various phenomena of living nature as exhibited by individual organisms, all looked on as the outcome of the activities of substances, species-plasms or idioplasms, conceived of as isomorphic, everywhere differentiative and directive, and not optically analyzable. But while the potential features of a species are not localized within its idioplasm, the latter may transform itself into visible intra-cellular differentiations of many kinds for the discharge of particular functions. All these are designated "substance organs." Whether such ideas are tenable time and the future history of our present concept of genes as persistent and self-perpetuative entities will show. However that may be, the reader turning the pages of this memoir, now forty years old and which did not come into its own at once but encountered some inept criticism, will readily recognize, employing the words of von Baer, that we have here "observations and reflections" of genius.

H. V. Wilson

RECENT DEATHS

The death at the age of sixty-one years is announced of Dr. H. B. Carey, professor of materia medica, botany and pharmacognosy and dean of the College of Pharmacy at the Medical Center, San Francisco.

Dr. Geoffrey M. James, formerly professor of chemistry at the University of Pennsylvania, died on February 17 as the result of an automobile accident. He was forty-five years old.

Dr. Henry M. Chance, mining and consulting engineer of Philadelphia, from 1874 to 1884 assistant state geologist of the Pennsylvania Geological Survey, died on February 19. He was eighty-one years old.

DR. THOR ROTHSTEIN, formerly professor of neurology at Rush Medical College, Chicago, died on February 20 at the age of seventy-two years.

RICHARD C. MCGREGOR, the managing editor of *The Philippine Journal of Science*, died on December 30 at the age of sixty-five years. He served for many years as ornithologist of the Bureau of Science and made numerous trips through the Philippines collecting specimens of birds. He wrote a number of articles on birds and bird life. His two-volume monograph and check list of Philippine birds are standard works.

SCIENTIFIC EVENTS

TOUR OF EUROPEAN INDUSTRIAL LABORATORIES UNDER THE AUSPICES OF THE NATIONAL RESEARCH COUNCIL

A TOUR of European laboratories in England, Germany and France for leaders in industry and banking from all sections of the United States has been arranged under the direction of the Division of Engineering and Industrial Research of the National Research Council, of which Maurice Holland is the director; Dr. Vannevar Bush, of the Massachusetts Institute of Technology, is the chairman, and Howard A. Poillon, of New York, is the vice-chairman.

According to present preliminary plans, the group will sail from New York on May 14 on the *S. S. Champlain*. While in Europe this delegation of American business leaders will visit the scientific research laboratories of private industry representing eighteen major fields, as well as the laboratories of governments, universities and trade associations.

This is the fourth educational tour of research laboratories conducted by the division for American executives. The other three projects, which were participated in by many business leaders, were tours to industrial and university laboratories in the United States. These were held in 1930, 1931 and 1935 under the direction of Mr. Holland.

While preliminary plans for the European tour have been under way for several years, details and the final program will be worked out by an advisory committee composed of industrialists and bankers who were members of the past tours. Invitations for the trip are now being sent to industrialists and bankers who are interested in research.

While in Europe organizations such as the Department of Scientific and Industrial Research in England, the Verein Deutscher Ingenieurs in Germany, the Sorbonne in France and others will be hosts. Membership in the party will be limited to a hundred in accordance with the request of several of the European engineering and scientific groups.

Members of the executive committee of the Division of Engineering and Industrial Research of the National Research Council are: Carl Breer, V. Bush, F. O. Clements, Galen H. Clevenger, E. S. Fickes, R. C. H. Heck, Frank B. Jewett, Fred Lavis, F. B. Llewellyn and Howard A. Poillon.

THE NORTH CAROLINA MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE annual meeting of the American Chemical Society will be held at the University of North Carolina from April 12 to 16. Programs will be presented for all divisions except Fertilizer Chemistry, the History of Chemistry, Leather and Gelatin Chemistry and Petroleum Chemistry. The preliminary program gives the following details:

The Division of Agricultural and Food Chemistry will meet all day Tuesday in joint session with the Divisions of Biological Chemistry and Medicinal Chemistry in a Symposium on the Vitamin B Complex. On Wednesday afternoon, the same divisions will cooperate in a Symposium on Vitamins Other than Those of the B Complex. On Wednesday morning, the Division of Agricultural and Food Chemistry alone will hold a Symposium on Flavors in Foods and Food Products and on Thursday morning a session for the presentation of general papers. The divisional luncheon will be held Thursday noon.

The Division of Biological Chemistry joins with the Divisions of Agricultural and Food Chemistry and Medicinal Chemistry in a Tuesday Symposium on the Vitamin B Complex and a Wednesday afternoon program on Vitamins Other than Those of the B Complex. On Wednesday and Thursday *mornings* divisional papers on other subjects will be presented.

The Division of Cellulose Chemistry will have a general symposium on Tuesday covering the present-day knowledge in certain fields of cellulose chemistry; the fields to be covered are not yet defined. General papers will be given in two Wednesday sessions.

The Division of Chemical Education will hold three sessions for the presentation of general papers, including an informal colloquium on the teaching of qualitative analysis.

The Division of Colloid Chemistry may cooperate with the Division of Cellulose Chemistry in its Tuesday symposium on present-day knowledge in certain fields of cellulose chemistry. On Wednesday two sessions will be held for presentation of general papers.

The Division of Gas and Fuel Chemistry will present a general program in two sessions.

The Division of Industrial Engineering Chemistry expects to schedule a large number and wide variety of general papers.

The Division of Medicinal Chemistry will join with the Divisions of Agricultural and Food Chemistry and Biological Chemistry on Tuesday in a Symposium on the Vitamin B Complex and on Wednesday afternoon in a

program on Vitamins Other than Those of the B Complex. General papers will be presented on Wednesday and Thursday mornings.

The Microchemical Section will hold one session for the presentation of general papers.

The Division of Organic Chemistry plans a program of miscellaneous papers in three sessions.

The Division of Paint and Varnish Chemistry has scheduled two sessions of general papers. A Symposium on Synthetic Plastics, under the chairmanship of Gordon M. Kline, will be held on Wednesday morning and afternoon and Thursday morning.

The Division of Physical and Inorganic Chemistry will hold a general Symposium on the Chemistry of Solid Surfaces, a half day of group symposia and probably three other sessions for general papers.

The Division of Rubber Chemistry will meet in three sessions for the presentation of miscellaneous papers.

The Division of Sugar Chemistry will hold two sessions, at which general papers will be given.

The Division of Water, Sewage and Sanitation Chemistry will meet on Tuesday for a program of general papers.

AWARDS OF THE AMERICAN INSTITUTE

Two awards of the American Institute of the City of New York for 1937—the Gold Medal to the Bell Telephone Laboratories, and a fellowship to Watson Davis, director of Science Service, Washington, D. C. —were made at the annual dinner of the institute on February 4.

Robert T. Pollock, president of the institute, presided and presented the awards. President Karl T. Compton, of the Massachusetts Institute of Technology, spoke on the work of the Bell Telephone Laboratories, and Dr. Frank B. Jewett responded. G. B. Parker, editor-in-chief of the Scripps Howard Newspapers, spoke on the work of Science Service, and Mr. Davis responded.

The gold medal, given annually in recognition of outstanding accomplishment in research, went to the Bell Telephone Laboratories "for research in electrical science which, applied to communication, have promoted understanding, security and commerce among peoples by transmitting human thought instantly throughout the world."

The fellowship in the institute, given for outstanding service in the interpretation of science to laymen, was conferred on Watson Davis, "for interpreting to the people of the nation the rapid progress of science upon which modern civilization depends and for the organized dissemination of research findings as news."

Progressive steps in the perfection of equipment needed for the faithful transmission of speech and music over great distances was demonstrated by the use of four telephone circuits by Dr. Perrine. Two of these, one a modern long distance line, and the other a modern high quality circuit used in hook-ups for radio broadcasting, extended two thousand miles from the banquet room to Danville, Illinois, and back to a special loud speaker on the platform. Two others were synthetic circuits created to give the effect of the best lines available for transcontinental telephony in 1915 and in 1920, but now no longer used. Music and speech were sent directly to the loud speaker and then through each of these circuits in turn for comparison. The loud speaker itself, weighing some 600 pounds, was a recent development based on four integral units, each amplifying sounds of particular frequencies. Effects of differences in circuits were shown by transmitting sounds of definite pitch as well as voice and music over the various lines.

The Council on Awards of the American Institute consist of: M. L. Crossley (chairman), Calco Chemical Company; Oscar Riddle, Carnegie Institution, Station for Experimental Evolution; W. H. Carrier, Carrier Engineering Corporation; W. D. Coolidge, General Electric Company; Oliver Kamm, Parke, Davis and Company; Ward F. Davidson, Brooklyn Edison Company; L. O. Kunkel, the Rockefeller Institute for Medical Research; Clinton J. Davisson, Bell Telephone Laboratories, and Harden F. Taylor, Atlantic Coast Fisheries.

AWARD OF THE WILLARD GIBBS MEDAL TO DR. McCOY

DR. HERBERT NEWBY McCOY, known for his achievements in radioactivity and in other fields of chemical science, has been awarded the 1937 Willard Gibbs Medal of the Chicago Section of the American Chemical Society. The medal will be presented at a dinner of the Chicago Section to be given on May 21.

Dr. McCoy, who was for sixteen years a member of the faculty of the University of Chicago and who is now vice-president and director of research of the Lindsay Light and Chemical Company, Chicago, was cited as "pioneer in a greater number of fundamental discoveries than any but three or four living American chemists." According to the notice sent us:

> Independently of and simultaneously with Robert John Strutt, now Baron Rayleigh, of England, and the late Professor Bertram B. Boltwood, of Yale University, Dr. McCoy was the first to establish experimentally that radium is produced by the spontaneous transmutation of uranium. He prepared the first organic metal, tetramethyl ammonium. He and Dr. William H. Ross, now of the U. S. Bureau of Soils, were the first to recognize clearly that isotopes are chemically inseparable substances. Dr. McCoy determined the first ionization constant of an indicator as a measure of its sensitiveness, and showed how the indicator participates in a reaction. He likewise made the first determination of the secondary ionization constant of a very weak electrolyte.

The Willard Gibbs Medal, founded by William A. Converse in 1911, was named for Josiah Willard Gibbs, professor of mathematical physics at Yale University

from 1871 to 1903, whose discoveries of the phase rule and other thermodynamical laws are the bases of modern processes of petroleum refining and of other chemical industries.

The 1937 medal jury was composed as follows: Professor Joel H. Hildebrand, of the University of California; Dr. Carl S. Miner, of Chicago; Professor Julius Stieglitz and Professor Hermann I. Schlesinger, of the University of Chicago; Professor Hugh S. Taylor, of Princeton University; Professor Harold C. Urey, of Columbia University; Dr. Ernest H. Volwiler, of the Abbott Laboratories, North Chicago; Professor Harry B. Weiser, of Rice Institute; Dr. George O. Curme, of the Union Carbide and Carbon Company, New York; Dr. Irving Langmuir, of the General Electric Company; Professor Ross A. Gortner, of the University of Minnesota; Dr. Eugene C. Sullivan, of the Corning Glass Works, Corning, New York.

SCIENTIFIC NOTES AND NEWS

DR. FREDERICK G. NOVY, professor of bacteriology emeritus at the University of Michigan, has been elected an honorary member of the Société de Pathologie exotique, Paris.

DR. B. R. KIRKLIN, of the Mayo Clinic, Rochester, Minn., has been elected a corresponding member of the German Röntgen Society.

THE Duddell Medal of the Physical Society, London, has been awarded to Dr. Walter G. Cady, professor of physics at Wesleyan University.

THE honorary degree of doctor of science was conferred on Dr. Charles Gordon Heyd, president of the American Medical Association, by Temple University at its Founders' Day exercises on February 15.

THE degree of doctor of pharmacy, *honoris causa*, was conferred by the Philadelphia College of Pharmacy and Science on Dr. Thomas Parran, Jr., surgeon general of the United States Public Health Service, on the occasion of the one hundred and sixteenth celebration of Founders' Day on February 23. Dr. Parran, who gave the principal address, spoke on "The Aims of the United States Public Health Service."

AT the annual dinner in New York City of the American Institute of Mining and Metallurgical Engineers, honors for distinguished service were awarded as follows: The William Laurence Saunders Gold Medal was awarded to Erskine Ramsay, chairman of the board and general consulting engineer of the Alabama By-Products Corporation of Birmingham. The first Anthony F. Lucas Gold Medal was awarded to J. Howard Pew, president of the Sun Oil Company. George S. Rice, chief mining engineer of the Bureau of Mines, Washington, D. C., won a certificate of honorary membership in the institute. The Robert H. Hunt prize for 1937 was awarded to William Floyd Holbrook, of the U. S. Bureau of Mines, and to Thomas L. Joseph, of the Minnesota School of Mines and Metallurgy in Minneapolis. John M. Hassler, engineer of the Southern District Republic Steel Corporation, of Birmingham, Ala., won the J. E. Johnson award.

THE 1936 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Dr. Frank Conrad, assistant chief engineer of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., "for his pioneering and basic developments in the fields of electric metering and protective systems." The medal and certificate will be presented to him at the annual summer convention of the institute, which will be held in Milwaukee from June 21 to 25. The Lamme Medal was founded as a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company, who died on July 8, 1924, to provide for the award of a gold medal annually to a member of the American Institute of Electrical Engineers, "who has shown meritorious achievement in the development of electrical apparatus or machinery."

IT is recorded in *Nature* that the council of the British Institution of Electrical Engineers has made the fifteenth award of the Faraday Medal to Professor André Blondel, of Paris. The medal is awarded not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the institution.

IN addition to the Wollaston Medal, which was awarded by the British Geological Society to Professor Waldemar Lindgren, of the Massachusetts Institute of Technology, for his researches concerning the mineral structure of the earth, the following awards have been made: the Murchison Medal to Dr. L. J. Spencer, in recognition of the value of his original contributions to mineralogical science and of his services to the publication of mineralogical literature; the Lyell Medal to L. Richardson, for his contributions to the geology of the Jurassic rocks of Great Britain; the Bigsby Medal to Professor C. E. Tilley, in recognition of the value of his researches in petrological science; the Wollaston Fund to Dr. D. Parkinson; the Murchison Fund to S. H. Straw. The Lyell Fund was

divided between J. F. Jackson and Miss M. E. Tomlinson.

OFFICERS of the American Institute of Electrical Engineers for the year beginning on August 1 have been nominated as follows: *President,* W. H. Harrison, assistant vice-president, Department of Operation and Engineering, American Telephone and Telegraph Company. *Vice-presidents:* Middle Eastern District, I. Melville Stein, director of research, Leeds and Northrup Company, Philadelphia; Southern District, Edwin D. Wood, general superintendent, Louisville Gas and Electric Company; North Central District, L. N. McClellan, chief electrical engineer, U. S. Bureau of Reclamation, Denver; Pacific District, J. P. Jollyman, hydroelectric and transmission engineer, Pacific Gas and Electric Company, San Francisco; and Canada District, M. J. McHenry, manager, Toronto District, Canadian General Electric Company, Limited. *Directors:* C. R. Beardsley, general superintendent of distribution construction, Brooklyn Edison Company, Inc.; V. Bush, vice-president and dean of engineering, Massachusetts Institute of Technology; and F. H. Lane, manager, Engineering Division, Public Utility Engineering and Service Corporation, Chicago. *National Treasurer,* W. I. Slichter, professor of electrical engineering, Columbia University.

THOMAS BUCKLEY, assistant chief engineer and surveyor of the Philadelphia Bureau of Engineering, Surveys and Zoning, has been elected president of the newly organized American Public Works Association.

CYRIL S. KIMBALL has been elected to succeed Dr. Foster Dee Snell as honorary secretary of the American Section of the Society of Chemical Industry. Dr. Snell served as honorary secretary for over ten years.

DR. EDWARD HIRAM MCALISTER, of the Oregon State College, having reached the age of seventy years, has retired with the title professor emeritus of mathematics. He has been connected with the Oregon State System of Higher Education for forty-six years.

DR. LEE FOSHAY, associate professor of experimental bacteriology, has been appointed professor of bacteriology and head of the department in the College of Medicine, University of Cincinnati, in the place of the late Dr. William B. Wherry.

DR. W. J. DE HAAS, professor of physics and meteorology at the University of Leyden, has been appointed Scott lecturer at the University of Cambridge for the next academic year.

DR. JOHN STIRLING YOUNG, professor of pathology in Queen's University, Belfast, has been appointed Regius professor of pathology in the University of Aberdeen, in place of Professor Theodore Shennan, who has resigned.

R. W. JAMES, reader in experimental physics at the University of Manchester, has become professor of physics in Capetown, South Africa. He has been associated with Professor W. L. Bragg in the study of the structure of crystals.

B. J. MARTLES, assistant lecturer in zoology at the University of Bristol, has been appointed to the chair of biology at the University of Otago, New Zealand.

DR. KENNETH F. MAXCY, professor and head of the department of preventive medicine and public health at the University of Minnesota, has been elected scientific director of the International Health Division of the Rockefeller Foundation. The appointment, which became effective on January 1, is for three years.

DR. GEORGE H. GODFREY, formerly of the Pineapple Canners' Experiment Station at the University of Hawaii, has been appointed plant pathologist at the Texas Agricultural Experiment Station at Weslaco, not at the University of California as stated in the issue of SCIENCE of February 12.

PHILIP C. STAPLES, president of the Bell Telephone Company of Pennsylvania, has been elected president of the Franklin Institute of Philadelphia. He succeeds Nathan Hayward, who resigned recently but continues as a member of the board of managers.

N. B. KINNEAR and Dr. H. A. Baylis have been appointed to deputy keeperships in the department of zoology of the British Museum.

THE Rockefeller Foundation has awarded a two-year grant of $10,000 to Professor James Franck, of the Johns Hopkins University, for research in photosynthesis and photo-observation.

DR. VICTOR G. HEISER has left for a five-months' tour of Africa. He will visit leper colonies and investigate the possible spread by airplane travel of yellow fever.

DR. MAURICE STACEY, of the staff of Professor W. N. Haworth, director of the department of chemistry of the University of Birmingham, England, is visiting the laboratories of the department of medicine of the College of Physicians and Surgeons, Columbia University, and the Presbyterian Hospital, New York, to engage in immunochemical studies.

DR. G. J. HUCKER, chief in research in bacteriology at the New York State Experiment Station at Geneva, has been granted six months' leave of absence to accept an invitation from the Government of New Zealand to spend four months in the Dominion conferring with bacteriologists, experts in dairy problems and veterinarians on a research program on the detection and control of mastitis and septic sore throat. Dr. Hucker will leave Geneva about July 1 and will divide his time between the University of Hamilton, the Veterinary

Laboratory at Wallaceville and the Dairy Research Institute at Palmerston North.

DR. HERMANN FISCHER, a son of Dr. Emil Fischer, professor of inorganic chemistry at the University of Basle, Switzerland, recently spent a week at the University of Toronto. On February 15 he gave a lecture before the Biochemical Society and on February 19 he spoke before the Chemical Society.

THE William Potter memorial lecture was delivered on February 11 by Dr. Henry A. Christian, Hersey professor of the theory and practice of physic at the Harvard Medical School. His subject was "The Fruition of a Clinician."

DISCUSSION

THE HEN'S EGG NOT FERTILIZED IN THE OVARY

IT is a well-known fact that the hen may continue to lay fertile eggs for two or three weeks or even longer after isolation from the inseminating male. Since it is rarely possible to recover normal, living spermatozoa a day after insemination (Barfurth, Lau, Anderson[1]) Iwanow[2] was led to consider the possibility of synchronous fertilization of a whole clutch of growing oöcytes *within the ovary*. Experimentally he found that hens would lay fertile eggs despite a thorough flushing of the body cavity and the oviduct with an appropriate spermicide. Walton and Whethan[3] were able to corroborate these results in that a lavage of the body cavity and of the oviducts of inseminated hens with such excellent spermicides as hexyl resorcinol or formaldehyde (Voge[4]) did not prevent the subsequent laying of fertile eggs. Nevertheless, these authors were loath to accept Iwanow's explanation of their results on the ground that spermatozoa can hardly be expected to pierce the thick capsule overlying the smaller oöcytes. This contention seems most reasonable.[5] Walton and Whethan furthermore point out that in these "Iwanow" experiments sperms hidden among the folds of the oviduct may well escape contact with the spermicidal lavage.

As the matter stands, therefore, it would seem that preovulatory fertilization in the bird is far from established so far as the foregoing experiments are concerned. It appears to the writer, however, that genetic proof against the Iwanow theory is already existent in the extensive data presented by Warren and Kilpatrick's experiments[6] on fertilization in the domestic fowl. These workers exposed laying hens alternately to males of different strains, all of which possessed dominant characters readily recognized in the chicks at an early stage of development. Thus, for example, in one series, eleven hens were penned with White Leghorn males for 21 days, then with Black Minorcas for 21 days, then again for a similar period with White Leghorns and so on. The results showed that in some cases as early as the second day after changing males the eggs laid had been fertilized by sperms from the replacing male. There was practically no overlapping of the offspring. The conclusion seems inevitable that the clutch of eggs were *not* coincidently fertilized in the ovary.

Harper[7] expressed the opinion that in the pigeon the ripe oöcyte about to rupture from its greatly attenuated follicle might be fertilized in this condition, since the wall is at this time but 3.5 μ thick. But even this seems unlikely, since the egg laid by the hen as much as 24 hours after insemination is always infertile, as has been known for over a century (Coste).

CARL G. HARTMAN
DEPARTMENT OF EMBRYOLOGY,
CARNEGIE INSTITUTION OF WASHINGTON,
BALTIMORE

1 W. S. Anderson, *Ky. Agric. Exp. Sta. Bull.* No. 239, 1922.

2 E. Iwanow, *C. R. Soc. Biol.*, Paris, 91: 54, 1924.

3 A. Walton and E. O. Whethan, *Jour. Exp. Biol.*, 10: 204, 1933.

4 C. E. B. Voge, "The Chemistry and Physics of Contraception," Jonathan Cape, London, 1933.

5 *Cf.* G. W. Bartelmez, *Jour. Morph.*, 23: 269, 1912.

6 D. C. Warren and L. Kilpatrick, *Poultry Science*, 8: 237, 1929.

7 E. H. Harper, *Am. Jour. Anat.*, 3: 349, 1904.

STRUCTURAL CONTROL OF THE FORM AND DISTRIBUTION OF SINK-HOLES

MALOTT's work[1] on Indiana caves shows interesting relations between subsurface forms and surface drainage; structural control of caves is shown remarkably well in McGill's treatise[2] on the Virginia Caverns. Martel's monumental work[3] is profusely illustrated with maps and cross-sections, many of which also show structural control, and Martel emphasizes energetically the tectonic influence in the development of sink-holes and caves, citing many instances of origin on fracture lines. However, specific reference to structural control in the form and distribution of sink-holes has escaped the present writer's notice.

1 Clyde A. Malott, "Handbook of Indiana Geology," Indiana Division of Geology, Indianapolis, pp. 94–98, 187–210, 233–247, 1922; also several papers in the *Proceedings of the Indiana Academy of Science*, notably in Vol. 38, pp. 201–206, 1928 (1929).

2 W. M. McGill, Virginia Geological Survey Bulletin 35, 1933.

3 E. A. Martel, "Nouveau Traité des Eaux souterraine," Paris, Chapter 2, 1921.

In 1933 while engaged in field work, preliminary to the building of the Norris Dam by the Tennessee Valley Authority, the writer noticed instances of obvious control of sink-hole form and distribution. In certain outcrop areas of the soluble zones of the Knox dolomite, where the dips were in the neighborhood of ten degrees and where the drainage water found inlet along the bedding planes, sink-holes showed the tendency to migrate down-dip. The form resulting was observed to be an unsymmetrical sink-hole, steep, and rock-walled in the down-dip direction, more gently sloping and soil-covered on the opposite side. Usually slight elongation in the strike direction was apparent. Several such forms were observed in the interstream upland between the Clinch and Powell Rivers near their confluence.

In more steeply dipping rocks the unsymmetrical profile was not apparent, but the tendency toward elongation in the strike direction was noticeable. The Ordovician limestones in the Buffalo Creek valley near Loyston, dipping twenty-five degrees to thirty degrees, showed not only elongation along the strike but alignment of sink-holes along the outcrop.

Observations of this nature have practical as well as physiographic value. The Buffalo Creek valley is a subsequent form and southwest of Loyston a very low divide separates northeast from southwest surface drainage. Some evidence is present to indicate the divide is shifting, or has recently shifted. The alignment of sink-holes, along the strike and across the divide, raised the perplexing question whether the division of subsurface drainage necessarily coincided with the division of surface waters, and, in practical engineering terms, whether an impounding dike at the divide would show subsurface leakage.

A. C. SWINNERTON

ANTIOCH COLLEGE

A METHOD OF DISPERSAL OF THE BLACK WIDOW SPIDER

GENERAL interest attends current mention or discussion of the black widow spider. The present note is prompted by an artificial though probably not uncommon means of this spider's dispersal that recently came to my attention.

On November 1, 1935, a lad, Richard Tortorice, of Albany, brought to the Office of Zoology at the New York State Museum a well-fed female example of *Latrodectus mactans*, which, he reported, had been taken from a box of California grapes the same day. The lad retained the spider in a glass jelly jar at the local high school, feeding it at intervals with flies, until December 3, when he returned it permanently to the museum.

We maintained the spider in an apparently healthful condition by supplying her with cockroaches and water from a saturated pledget of cotton until January 9, 1936, when she died. On the night of December 22, 1935, the spider attached a cocoon to the under side of the wire gauze covering the jar, but spiderlings never issued from it.

Perhaps the most interesting fact in this enumerated chain of events was the successful consummation of a railroad journey from California to Albany, New York, by this particular black widow spider. It affords still another illustration of the dispersal of a species by man-made devices. Had the spider been freed under more salubrious climatic conditions she might well have been responsible for the establishment of the species in that locality and a different story might have been associated with this importation.

DAYTON STONER

NEW YORK STATE MUSEUM

CONCERNING FOSSIL LEGUMES

IN a recent number of SCIENCE,[1] E. B. Ford, I. L. Baldwin and Elizabeth McCoy expressed the hope that some paleobotanist would report observations regarding fossil nodules from the roots of leguminous plants. As these writers intimated, other fossil remains of Leguminosae, such as leaves, fruits, seeds and wood, have been reported; but there are no authentic records of fossil root nodules. The hope that such may be discovered is, I am afraid, doomed to be deferred indefinitely, because these relatively minute structures are generally delicate and evanescent and are unfavorably situated for preservation as fossils.

Only remotely analogous to leguminous rootlets and root nodules are the rhizomes and tubers of *Equisetum*, which are sometimes preserved as fossils.[2] These survive because they are composed of fairly resistant tissues and because they grow along banks of streams or the edges of marshes where, when detached, they are likely to be buried in sediments and subjected to the processes of fossilization.

Fossil objects that have sometimes been regarded as underground leguminous fruits, like peanuts, are those called *Leguminosites*? *arachioides* Lesquereux[3] and *L. a. minor* Berry.[4] I propose in a paper now being prepared to present evidence that these objects are not legumes, but the fruit pods of an extinct trochodendraceous group of plants having *Populus*-like leaves and producing small winged seeds.

ROLAND W. BROWN

U. S. GEOLOGICAL SURVEY

[1] SCIENCE, 85: 45, 1937.

[2] Oswald Heer, *Flora fossilis arctica*, 2(3): 31, pl. 1, figs. 1–15; pl. 2, figs. 1–4, 1870. Leo Lesquereux, U. S. Geol. Survey Terr. Rept. 7: 67, pl. 6, figs. 2–4, 1878.

[3] Leo Lesquereux, *idem.*, p. 301, pl. 59, figs. 13, 14.

[4] E. W. Berry, U. S. Geol. Survey Prof. Paper 156: 89, pl. 14, figs. 2–6, 1930.

THE NATIONAL ASSOCIATION OF SCIENCE WRITERS

THROUGH a regrettable oversight, I neglected to include the name of Allen Shoenfield, of the *Detroit News*, in the list of charter members of the National Association of Science Writers in my recent address before the American Association for the Advancement of Science. I trust that all those who turn to the published address, "Science and the American Press," SCIENCE, January 29, for the complete membership of the National Association of Science Writers will add the name of Mr. Shoenfield.

DAVID DIETZ

CLEVELAND, OHIO

REPORTS

GEOLOGICAL SURVEY OF NEWFOUNDLAND REVIVED

OFFICIAL geological surveys of the island of Newfoundland were begun as early as 1839 (James Beete Jukes, 1839–40) and carried out intensively by a small personnel for half a century (Alexander Murray, 1864–1883; James P. Howley, 1869–1909; Dr. Herbert A. Baker, 1926–1929). The advances in the science of geology since the pioneer work was performed are so great and the need of up-to-date information on the mineral resources so pressing, however, that on its induction into office in 1933 the new Commission of Government, appointed by the British Crown, authorized the resumption of the Geological Survey by a Geological Section of the Department of Natural Resources.

The nucleus of the staff of the Geological Section consists of two Newfoundlanders: Dr. A. K. Snelgrove, assistant professor of geology in Princeton University, was appointed government geologist, and Mr. C. K. Howse, B.Sc., assistant government geologist. Dr. Snelgrove continues in his Princeton position, also.

Following the recent practice of the Geological Survey of Canada and of Surveys in Crown Colonies, the field work of the Geological Section is devoted primarily to investigations in economic geology, designed to foster the mining industry. The reports on this work are issued as a series of bulletins, the purpose of which is to provide a scientific foundation for mineral exploration and exploitation. Areal studies in particular are yielding fundamental data on the structure, stratigraphy and petrogenesis of this most northeasterly part of the Appalachian Mountain System of North America. For the benefit of prospectors, areal geological sheets are distributed separately, with a simple description of the character and manner of occurrence of economic mineral deposits known or likely to be present. Already published are the results of surveys of chromite and gold deposits by the Government Geologist, and of two areal geological studies in cooperation with the Department of Geology of Princeton University: The Bay of Exploits area, by Dr. G. R. Heyl, and the Southern Half of the Bay of Islands Igneous Complex, by Dr. J. R. Cooper. A bibliography of Newfoundland geology, 1818–1936, by Rachel M. Betts, Guyot Hall Library, Princeton University, forms Bulletin No. 5, which was issued recently.

In the past field season an unusually comprehensive program of geological mapping was carried out, with the assistance of a temporary staff of a score of geologists in the areas represented in Fig. 1. Geodetic control is being provided for the topographical base maps by a five-year geodetic survey program now in progress in cooperation with the Geodetic Service of Canada, under a grant from the Colonial Development Fund.

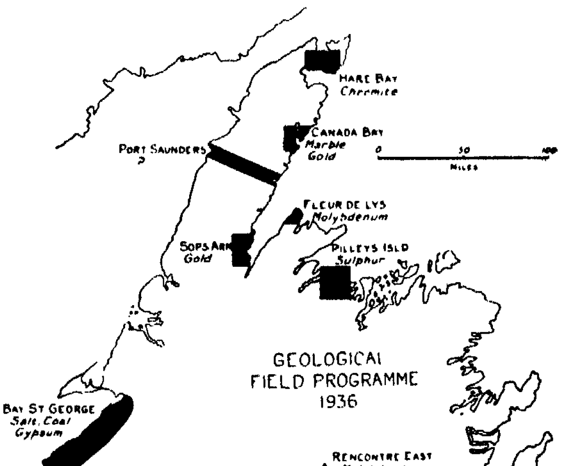

FIG. 1. Newfoundland geological map areas, 1936.

As Princeton University Geological Expeditions have been sent to Newfoundland intermittently since 1911, and fourteen Princeton contributions to the geology of the island have already been published, it is natural that a majority of the geologists called in on this expanded government work were from Princeton. However, the faculties or student bodies of seven other American and Canadian universities were also represented. Notable members of the temporary and

consulting staffs include: Professor G. W. Bain, of Amherst College, who studied the promising marble deposits of Canada Bay and Sops Arm; Professors A. O. Hayes and H. Johnson, of Rutgers University, who investigated the Bay St. George Carboniferous area; Professor B. F. Howell, of Princeton University, authority on Cambrian formations; Professor W. H. Twenhofel, chairman of the Department of Geology of the University of Wisconsin, authority on Silurian rocks. In addition ten Princeton geologists, chief among whom were Professor A. F. Buddington, chairman of the Department of Geology, Professor E. Sampson and Dr. H. H. Hess, engaged in faculty research, consultation to mining companies or collection of data for theses.

Through the participation of Mr. J. W. Sullivan, graduate student at Yale University, the studies in the geology of the west coast made by four Yale expeditions since 1910 were continued.

The Geological Section also acts in an advisory capacity to the Labrador Mining and Exploration Company, Ltd., holders of a mineral concession of over 20,000 square miles in Newfoundland Labrador, on which extensive work was begun last summer and is to be continued for a number of years.

The present geological activities are being followed up by prospecting and exploration by local, Canadian, United States and English interests, and it is anticipated that a number of the campaigns now in progress will yield tangible results in the form of development of latent resources and afford some amelioration of the economic difficulties which confront Newfoundland.

A. K. Snelgrove

Princeton University

THE THIRTY-THIRD MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

The American Geographers met in Syracuse, N. Y., in their thirty-third annual meeting on December 31, 1936, and January 1 and 2, 1937, Professor William Herbert Hobbs, of the University of Michigan, president of the association, in the chair. The meetings were exceptionally well attended, and the papers presented aroused a great deal of interest and discussion.

The secretary, Preston E. James, of the University of Michigan, had constructed the program about several major themes. Among them were: "North America, the Northeast," four papers; "South America," two papers; "The Classification and Use of Soils," four papers; "North America, Urban Studies," five papers; "North America, the Western Mountains," six papers; "Polar Exploration," seven papers; "North America, the Appalachians and the South," six papers; "North America, Climatic Studies," four papers; "The Far East," four papers, and "Europe," four papers.

A memorial to the late Oliver L. Fassig; a special symposium on "Problems in the Cultural Geography of North America" for the members only; an illustrated lecture on "Kano," one of the principal centers of life in the Sudan, by Derwent Whittlesey, of Harvard University; the annual banquet, at which Acting Chancellor William P. Graham welcomed the membership to Syracuse University, the award for studies in physical geography was announced and President William Herbert Hobbs delivered his presidential address on "Discovery and Exploration within the Arctic Circle"; a number of desultory but valuable papers, not directly related to the group papers, completed the program. The arrangement of papers in selected fields expedited discussion by concentrating interest upon those fields and enabled the presiding officer to run the program quite on schedule.

Among the studies which elicited most discussion and interest were: "Season of Birth, and the Distribution of Civilization," by Ellsworth Huntington; three papers dealing with erosion surfaces and the physiographic evolution of the Rocky Mountain region by the Wallace W. Atwoods, of Clark University, father and son, who have made that region their major field of research these many years; "An Optical Phenomenon and Its Relation to the Discovery of Polar Lands," whereby William H. Hobbs submitted his arguments that the long-sought "Crocker Land" of the Arctic Ocean may still remain to be discovered though farther at sea than has been supposed, and that the mapping of land in the Antarctic by Wilkes and others where no land has since been shown to exist can be fully explained by a peculiar form of mirage; "Lower Mississippi Valley Loess," in which Richard Joel Russell, of Louisiana State University, implied a residual genesis for some of the deposits bordering the Mississippi Delta, and the groups of papers on soils, the Far East and Europe. A particularly valuable paper by W. L. G. Joerg, of the American Geographical Society, "The Geography of the Antarctic: The Advances of a Decade, 1926–1936," summarized a field which has been prominent in public news and attention for many years.

A noteworthy feature of the banquet program was the first award of the fund for research in physical geography, recently established by Wallace W. Atwood, of Clark University, formerly president of the Association of American Geographers, to Richard Joel Russell, of Louisiana State University, in recognition of his meritorious original investigation of a number of problems in physical geography and in approval of a special study of the Volga delta to which he plans to devote the funds. The fund will be administered

by the executive council of the association and awarded, at intervals, whenever, in its opinion, an outstanding project is proposed by some member of the association who has already achieved notable results in original research.

The officers chosen for the ensuing year are: *President,* W. L. G. Joerg, of the American Geographical Society, New York; *Vice-President,* Guy-Harold Smith, Ohio State University, Columbus; *Secretary,* Preston E. James, University of Michigan, Ann Arbor; *Treasurer,* John E. Orchard, Columbia University, New York; *Editor,* Derwent Whittlesey, Harvard University, Cambridge, Mass. The councilors are: C. C. Colby, University of Chicago; William H. Hobbs, University of Michigan; Kirk Bryan, Harvard University; Richard Joel Russell, Louisiana State University, and Richard Hartshorne, University of Minnesota.

The executive council has decided upon Ann Arbor, Michigan, as the place of the next annual meeting.

SPECIAL ARTICLES

LOCALIZED CORTICAL GROWTH AS THE IMMEDIATE CAUSE OF CELL DIVISION

CHAMBERS[1] supports the theory that cell division is caused by the growth of two viscous astral spheres separated by a liquid zone, in combination with a probable change in surface tension. Gray[2] thinks the growing asters displace fluid peripheral cytoplasm to the walls of the furrow, where cleavage occurs apparently because the fluid material is reduced in amount by conversion into the more viscous substance of the aster (see especially his figure 92). Spek[3] assigns the dominant rôle to an increase of surface tension in the region of the furrow and to the subsequent flow of peripheral cytoplasm into the furrow. Heilbrunn[4] is inclined to the view that astral rays "pull on the surface membrane of the cell" (p. 272).

In an analysis of the surface kinetics of the cleaving amphibian egg, I have obtained results which point to a mechanism different from any of the above. Vogt's method of localized vital staining,[5] in combination with a study of serial sections, was used to obtain a fairly detailed picture of the behavior of the egg cortex in the Pacific Coast newt, *Triturus torosus.* The explanation suggested seems equally applicable to certain invertebrate eggs, to judge from the recent descriptions of Motomura.[6] The main phenomena observed in *Triturus torosus* are as follows:

(1) Cleavage is initiated by a contraction of the egg cortex at the site of the future furrow. This is a contraction in the sense that the cortex becomes thicker and bulges toward the egg interior. At the same time the surface of the egg is displaced toward the site of thickening.

(2) The mid-portion of the contracted cortex begins to expand within one to two minutes after the above contraction (at temperatures ranging from 22° to 26° C.). The pigment of this expanding portion is rearranged in irregular streaky lines, plainly indicating that the cytoplasm is being stretched. The surface of the stretched material sinks below the general egg surface much as does the surface of a fluid material stretched between relatively firm supports. Chambers[1] gives other evidence that this zone is liquid in his observation of Brownian motion and his micro-dissection experiments. The stretched cortical material ("the primary furrow") has a lower concentration of pigment per unit surface and therefore appears lighter than the rest of the upper hemisphere (see Fig. 1).

(3) A secondary furrow appears at about the center of the primary furrow. It gives evidence of additional stretching of its materials.

(4) The pigmented cortex bounding the lightly pigmented "primary furrow" becomes the site of intense growth directed toward the egg interior. Vitally stained marks placed in this position are drawn out into long delicate hair-lines as the furrow deepens. Only a narrow strip of the cortex adjacent to the early furrow undergoes growth; this applies to the top (pigmented) surface of the egg (see Fig. 1). On the *lower* (unpigmented) side of the egg a much wider strip of cortex is involved. As surface-cortex is converted into furrow-cortex, its content of clear cytoplasm increases, with a corresponding decrease in the concentration of pigment and yolk "granules."

The streaming of peripheral cytoplasm from the sides of the egg into the furrow, which has been described by a number of persons,[7] is noticeably absent in the cortex. The streaming observed was in all probability a *sub*-cortical movement only, as has been suggested by Motomura[6] also. This is supported by the recent work of Motomura[6] and of Brown[8] as well as

[1] R. Chambers, in "General Cytology," ed. by E. V. Cowdry, Section V, 1924.

[2] J. Gray, "A Textbook of Experimental Cytology," chapter 9, 1931.

[3] J. Spek, *Arch. f. Entw.-mech.*, 44: 5, 1918.

[4] L. V. Heilbrunn, "The Colloid Chemistry of Protoplasm," chapter 15, 1928.

[5] W. Vogt, *Arch. f. Entw.-mech.*, 106: 542, 1925.

[6] I. Motomura, *Sci. Reports of the Tohoku Imper. Univ.*, 4th Series, 10: 212, 1935.

[7] See the works of Chambers, Gray and Spek already cited.

[8] D. E. S. Brown, *Jour. Cell. and Comp. Physiol.*, 5: 335, 1934.

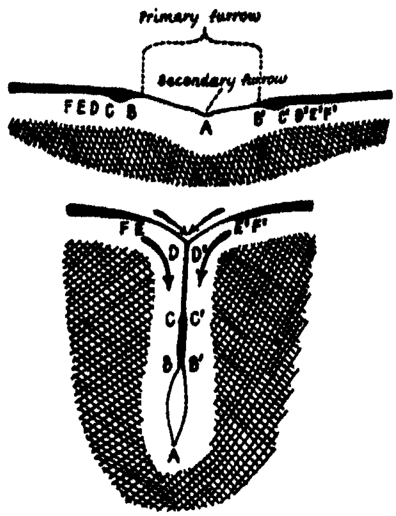

FIG. 1. Diagram illustrating the manner of cortical growth described in the text. Cortical pigment is shown as a solid black line. Remainder of cortex white. Subcortical cytoplasm cross-hatched. The top sketch represents an early stage of cleavage, the lower one a more advanced stage. Arrows indicate direction and approximate site of growth. Corresponding portions of the cortex indicated by letters A, A′, etc.

my own work which shows that the cortex (of the *Strongylocentrotus, Arbacia* and *Triturus* eggs, respectively) is a more or less rigid layer during cell division.

A reasonable explanation of the observed cortical growth, in view of its localized character, is that the increase may be due to an imbibition process, which of course does not imply that the cortex becomes "fluid." Indeed there are indications that the cortex of the furrow, excepting a small part near its tip, does not differ much in viscosity from the rest of the egg cortex. At least the difference is not great enough to give rise to the characteristic surface contours of fluids in contact with relatively solid materials. It is well known that the swelling pressure of bio-colloids may attain high values under proper conditions, and the relatively fluid material which Chambers[1] ascertained in the equatorial region of the cleaving egg would offer little resistance. It is also possible that the growth of the furrow-cortex is by intussusception of clear cytoplasm of *sub*-cortical origin; this might explain the part played by the cytoplasm which some workers have seen streaming toward the furrow. Both processes might be involved, since they are obviously not antagonistic.

This view of the mechanism of cell division has certain features in common with the sol-gel transformations generally regarded as important in the formation of pseudopodia in certain amoebae. The *protrusion* of the pseudopodium involves the localized growth of a peripheral gel cylinder at the expense of a centrally located sol. Is it a mere superficial coincidence that the *intrusion* of the cell surface seems also to involve a localized growth of peripheral cytoplasm at the expense of the more fluid elements of the cell?

Details will be published elsewhere.

A. M. SCHECHTMAN

UNIVERSITY OF CALIFORNIA AT LOS ANGELES

HOW CONSISTENT ARE AN INDIVIDUAL'S BRAIN POTENTIALS FROM DAY TO DAY?

IN a previous article, we showed that an individual can be distinguished from other individuals by his brain potentials.[1] An important and related question left unsettled was: Are an individual's brain potentials consistent from time to time?

To answer this question, we obtained on five different days (as a rule not consecutive) an adequate sampling of brain potentials from each of 11 healthy university students (6 men, 5 women). No attempt was made to run a subject at a certain time of the day or to control in any way his daily routine of living. A strong effort was made, however, to keep the experimental conditions as constant as possible from subject to subject and from day to day for the same subject. The observer reclined on a cot in a dark and electrically shielded room. He was instructed to keep his eyes closed and his mind as "blank" as possible. The brain potentials were led off from the left occipital area by means of a surface electrode. A ground electrode was attached to the lobe of the left ear. Standard amplifiers and a Westinghouse oscillograph were used for recording.

Because of the amount of space necessary to display them, the 55 records (5 records from each of 11 subjects) were divided into three groups, two groups of 20 records each and one group of 15 records. Each group contained all the records of 3 or of 4 subjects, as the case might be. The records in each group were thoroughly "shuffled" and chosen at random for pasting on a wall. One group was studied at a time. Each record was given a number. Four of us, who had served as judges in the previous study on identification, served again here. The task was to study the mounted records and to arrange them according to their numbers into groups of five. Each group of five was to have in it all the records, and only the records, of one subject. The person comparing the records was not told whether he was wrong or right in his judgments until he had finished with an entire group of 15 or 20 records.

A total of 220 judgments were made (4×55).

[1] L. E. Travis and A. Gottlober, SCIENCE, 84: 532, 1936.

Ninety-one per cent. of the records were correctly assigned (20 errors). Three of us made 4 errors each, and one of us made 8 errors. One of us made no errors in one group of 20 records, and another of us in the other group of 20 records. One of us made no errors in either of the two groups of 20 records each. According to the law of probability, by chance one could expect to assign accurately 20 records once in 488,864,376 times, and 15 records once in 126,126 times. We feel that chance played practically no rôle whatsoever.

As was to be expected, the records of some individuals were more distinctive and consequently more easily grouped than were those of other individuals. The records of 6 of our subjects were strikingly similar and consequently difficult to classify. Such criteria as frequency, amplitude and form of the waves played their part in making accurate judgments possible. Also, we evaluated the records as a whole, considering such factors as trains of waves, stability of the base-line, and fluctuations in the frequency and amplitude of the waves. No other cues incident to photography, handling of the paper or differences in the width of the time-line could possibly contribute to the accuracy of our judgments, since always the records of *different* individuals were taken, developed and handled together. This means that cues arising from such sources would make the same individual's records unlike instead of alike.

Our conclusion is that not only can an individual be distinguished from other individuals by his brain potentials, but under relatively constant experimental conditions an individual's brain potentials are highly consistent from day to day.

LEE EDWARD TRAVIS
ABRAHAM GOTTLOBER
STATE UNIVERSITY OF IOWA

MICROSTRATIFICATION OF THE WATERS OF INLAND LAKES IN SUMMER

THE thermal stratification of temperate lakes into three general regions in summer, namely, epilimnion, thermocline and hypolimnion, has been known for many years. Recent investigations show, however, that there is also a sharply marked microstratification in the thermocline and hypolimnion which has not been found hitherto. This phenomenon was discovered by means of a new type of apparatus for measuring the transparency of water, which is similar to that employed by Hans Pettersson[1] on Norwegian fjords; it was used on several Wisconsin lakes during the past summer and gave some very interesting results, four of which are illustrated in Fig. 1.

The apparatus consists of a light source, which is a three candle power automobile light bulb, and a photo-electric cell for a receiver; each of these is mounted in a metal water-tight housing which has a flat glass window about three centimeters in diameter. The light and receiver are attached to a piece of galvanized iron pipe one meter apart, with the windows facing each other. A condensing lens immediately in front of the light focusses a beam of parallel light on the photocell window.

Insulated wires lead from the housings of the light and photocell to a wire cable which connects them with the battery and the reading instrument in the boat. The cable is 35 meters long. An amplifier, a series of resistances and a potentiometer are included in the circuit for the purpose of amplifying the current from the photocell and also for the adjustment of the microammeter to any desired zero point. In its latest form a rubber hose is attached to the iron pipe for the purpose of pumping up samples of water from the different depths and also an electric thermometer for taking temperature readings. A separate light source for taking measurements of light scattering is also included.

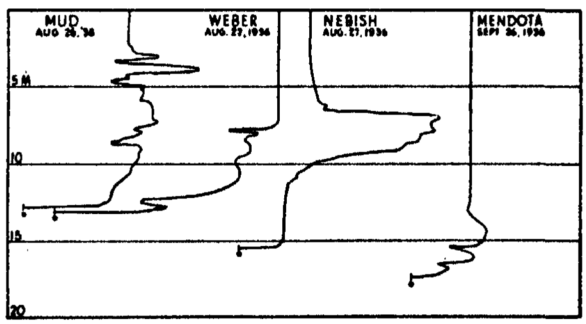

FIG. 1. Relative transparencies of the waters of four Wisconsin lakes at different depths.

The results obtained with this instrument show that the transparency is uniform throughout the upper stratum of water, or the epilimnion, which is kept in circulation by the wind (see Fig. 1). In the thermocline and hypolimnion, on the other hand, the water is stratified alternately into more transparent and less transparent layers. These layers may be only a few centimeters thick, as in Mud Lake, or they may be one or two meters thick, sometimes more. A marked decrease in transparency is always found within a meter or two of the bottom. Similar stratifications were found at different stations in the same lake, which indicates that it is not a local phenomenon.

The curve for Nebish Lake differs from the others in that a three-meter layer of water in the thermocline was more transparent than the epilimnion. In Mud

[1] H. Pettersson, *Jour. du Conseil Int. pour l'Expl. de la Mer*, 10: 1, 1935.

Lake the two layers in the thermocline that were more transparent than the epilimnion were only a few centimeters thick. In some series certain layers in the hypolimnion were more transparent than the epilimnion.

Preliminary tests show that part of the material which causes the lower transparency can be removed from the water with a high-speed centrifuge. In one case Daphnias were found in considerable numbers in the layer with low transparency; plate counts also show that bacteria are more numerous in the layers with minimum than in those with maximum transparency.

L. V. WHITNEY

LIMNOLOGICAL LABORATORY,
UNIVERSITY OF WISCONSIN

SCIENTIFIC APPARATUS AND LABORATORY METHODS

USE OF THE LANTERN FOR OBJECTIVE EXAMINATIONS

THIS method has been used with large classes in elementary physiology in the General College and other divisions of the University of Minnesota.

At the beginning of the term each student is assigned to either an odd or an even numbered seat. Sometimes the class is merely divided into odds and evens and told to take seats accordingly. The odds are known as Division A, the evens as Division B.

Each student receives a stapled packet of about 25 mimeographed slips, 11 by 4½ inches, pink for A's and blue for B's. Students are instructed to bring these slips to lectures. The slips have space for student's name and 25 numbered blanks for answers to questions. At the top is instruction for A's to answer only "A" questions, B's only "B" questions.

Slides of ordinary type and size are used. The usual slide holder permits illumination of an area 3 by 3½ inches. Judicious whittling will increase the area exposed to 3¼ by 3½, the cover glasses being bound together only at ends. On this area six short questions can usually be typed, three A's and three B's. If questions are longer, four are typed on each slide.

The "Radio-Mat" method of typing slides is used. However, as sold, these expose an area of only 2¼ by 3 inches. We find it cheaper and more convenient to buy the red copying paper and Cellophane in letter-size sheets, cutting the copies into proper size before mounting between glasses.

Any of the ordinary objective types of questions may be used. Omission of unnecessary words and use of understood abbreviations shorten questions and increase number on each slide.

A sample slide, alternative answer type, is shown below. Students understand the symbol / as separating alternative answers and equivalent to the word "or." The same questions are given to both divisions but in different order.

A1 Conditioned reflexes investigated: Pavlov/Sherrington/Cannon/Magendie.
A2 Example involuntary non-reflex activity: constriction pupil/ciliary action/goose flesh/swallowing.
A3 Chief motor tracts cross: cerebrum/cerebellum/medulla/cord.
B1 Respiratory center located: cerebrum/cerebellum/medulla/cord.
B2 Example smooth muscle reflex: sneezing/winking/knee jerk/blush.
B3 Autonomic N.S.: wholly efferent/wholly afferent/mixed.

Teachers having lanterns for opaque projection could doubtless make direct use of typewritten questions.

A quiz may include any number of questions. We have used ten to fifty. Usually one purpose has been to take a roll call and check tardiness. Unannounced quizzes of ten questions served these purposes.

Almost no cheating has been observed. Although in adjacent seats, the odds and evens are too busy concentrating on their respective jobs.

Slides are filed for use with future classes. Usually copies of questions are posted after quizzes.

Last year we experimented with two lanterns. This method has the advantage of permitting a larger number of questions on view at a given time, "A"s on one screen, "B"s on the other. It also makes it easier to use multiple choice answers, questions on one slide, answers on the other.

Several members of the physiology staff made useful suggestions, especially Drs. Hugo Miller and Carroll Bellis.

E. P. LYON

MEDICAL SCHOOL,
UNIVERSITY OF MINNESOTA

APPARATUS FOR PRODUCING CUMULATIVE AND ORDINARY TYPE KYMOGRAPH RECORDS SIMULTANEOUSLY

A QUANTITATIVE representation of physiological data given by the ordinary type kymograph record would, in many instances, be of advantage, particularly so in the comparison of sets of data. A method has been described[1] by which this may be accomplished in measuring the activity of small animals. The present article presents a method applicable to a much wider range of experimentation. A simple muscle preparation will serve to illustrate the method.

[1] K. M. Wilbur, SCIENCE, 84: 2177, 274, 1936.

An oiled glass rod (R) of ⅛″ diameter forms a support for a sliding wire collar to which is attached a writing lever (L), resting against a horizontal kymograph drum (K1). Less than 50 milligrams were required to produce movement of the writing lever, even when no special precautions were taken to insure ease of movement of the sliding collar and the writing lever. A silk thread passes from the sliding collar through three glass loops (G). The thread is weighted with a small piece of plastic clay (W). The short arm of a muscle lever (A) extends over the thread. Two glass rods (not shown in figure) on either side of the muscle lever allow only vertical deflection of the thread. The contraction of the muscle (M) pulls down lever (A) causing the thread to be depressed. The depression of the thread causes the writing lever to be pulled to the right, since the weighting arrangement does not permit the other end of the thread to move. When the muscle relaxes the weight drops slightly, pulling the thread taut without further displacing the writing lever. Thus, the lever will move only during contraction, and the curve produced will be cumulative as the muscle contracts. The greater the frequency of contraction the more rapid will be the rise of the curve. The curve will also rise more rapidly if the amplitude of contraction is increased. Simultaneous with the making of the cumulative record on K1 another record of the usual type is being obtained on K2. Both the change in frequency and amplitude will be indicated in the cumulative curve, although less clearly than in the ordinary record, since each contraction is represented by a discrete step in the curve. The height of the curve at any point will be proportional to the total contraction up to that time.

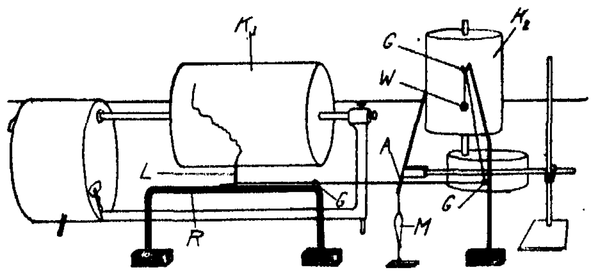

FIG. 1

By a slight modification of the apparatus records may be obtained from levers moved by rubber tambours.

K. M. WILBUR

OHIO STATE UNIVERSITY

ANOTHER CARBORUNDUM PENCIL

WE have been using in our classes a method of mounting engravers' points for marking microscope slides which seems both simpler and more satisfactory than that devised by Chatters.[1]

Glass tubing just large enough for insertion of an engravers' point is selected and cut in four-inch lengths. With the aid of heat the blunt end of a piece of carborundum is coated with a thin layer of sealing wax, and while the wax is still soft the carborundum is inserted to about half its length in one end of the glass tubing. The student's name is then written in India ink on a narrow piece of card, which is pushed into the tube far enough to avoid scorching when the open end is either fire polished or sealed.

Pieces of carborundum mounted in this way have been in use in the histology class at Yale for several years. The insertion of a name card was the idea of a student at Smith.

ESTHER CARPENTER

SMITH COLLEGE

[1] SCIENCE, 85: 128, January 29, 1937.

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PSYCHOLOGY AS A QUANTITATIVE RATIONAL SCIENCE[1]

By Professor L. L. THURSTONE
THE UNIVERSITY OF CHICAGO

THE purposes of this society are not new, but they represent an emphasis and direction which have not hitherto received major consideration in psychological science. It seems proper that we should devote some share of our first program meeting to a consideration of our main objectives.

Our main purpose is briefly stated in the subtitle of the new journal, *Psychometrika*, namely, to encourage the development of psychology as a quantitative rational science. More briefly, this may be called mathematical psychology. We should justify our emphasis upon quantification and upon rationalization in science, as well as our conception of the fundamental nature of science.

I assume that we are in complete agreement that we can not suddenly quantify our comprehension of psychological phenomena over their entire range. As psychologists, we are as interested as ever in making exploratory studies of new psychological effects and in discovering hitherto unknown effects. At present, the range of psychological phenomena that can be profitably reduced to mathematical formulation is limited, and it is likely that every man who works on a problem of mathematical psychology will also concern himself with exploratory studies of other problems that are as yet too new for detailed rationalization.

After the discovery of a psychological effect, we naturally turn to the second phase of scientific inquiry, namely, to relate the new effect in a simple descriptive manner to what is already known. In this stage, theories are devised to explain the experimentally known effects, and we try, of course, to make psychological theories less complicated than the effects that are to be explained. In this phase the descriptions of psycho-

[1] Abstract of address by the retiring president of the Psychometric Society at Hanover, N. H., September 4, 1936.

logical effects are quantified but seldom rationalized. Rough indices of covariation are in general sufficient. It is not often crucial that certain particular quantities are observed; it is enough to know that one sort of thing is larger than some other, or that one sort of thing tends to be directly or inversely related to something else.

A later phase is that in which theories in a given field are unified in terms of a relatively small number of postulates whose consequences can be deduced by logical considerations. The resulting formulations are submitted to experimental test with the requirement that the functions and the parameters produce meaningful results. This phase of inquiry is much more demanding than the generally descriptive type of work, and consequently many more failures of experimental verification are to be expected.

The mathematical and rigorous treatment of a psychological problem is in no sense a substitute for the exploratory and descriptive types of experimentation. In general, mathematical formulation of a problem can only follow upon the exploratory and descriptive studies by which we first become familiar with the phenomena that call for reduction in more rigorous analysis. The history of science shows exceptions where analytical formulation far preceded experimental knowledge, but these exceptions are not a safe guide for most of us. Most of us will be the more useful by staying close to experimental check. The flights of analytical genius are attended with a risk of error that is proportionate to separation from the laboratory.

Let us mark, then, three differentiable stages of scientific inquiry—exploration, descriptive relation and rationalization. It is to be noted that every science has problems in each stage of development. No science can be characterized as entirely of one type. In a young science like ours, it is to be expected that most of our work is in the first two phases, but it is encouraging to find that some of our problems can be pushed toward more rigorous treatment.

For the past twelve years I have been trying to introduce quantitative rational theory into psychology. Instead of merely discussing this subject in general terms, I shall describe some attempts to put these ideas into practice.

In building a unifying rational structure for psychophysics, I began by considering a simple table showing the frequency with which each of several stimuli is judged to be stronger than each other stimulus. The first question was then, to ascertain whether such a table reveals some underlying order or law. I found a few simple postulates that would lock the whole table of experimentally determined proportions. These included a new concept in psychophysics, namely, the discriminal error. The result was the law of comparative judgment. Armed with this law, we can investigate the relations of the several psychophysical methods. For example, the simple method of rank order can be theoretically related to the constant method so that one set of experimental results can be predicted from the other.

An interesting result is that we can ask new questions which we had not thought of before. If the discriminal error is an attribute of each stimulus, what should be the consequences when this value is larger than in the conventional limen determinations? If the analysis is sound, then the so-called psychometric curve should be positively skewed for coarse discrimination. Experimental results on brightness discrimination of rats verified the theory. The new psychophysical concepts are applicable to the measurement of affective values, such as in esthetics, and to many other forms of cognitive and affective discrimination. These concepts and laws are quantitatively formulated and they can be tested experimentally. Psychophysical experimentation is no longer limited to those stimuli whose physical magnitudes can be objectively measured.

One of the best possibilities for the development of rational theory in psychology seems to be in the study of learning. It is a matter of very general observation that in certain forms of rote learning the errors are gradually eliminated until a perfect performance is attained. In the descriptive theories of learning occurs the idea that the making of an error has the effect of reducing the probability of its recurrence, and that a successful act tends somehow to augment the probability of its recurrence. In a first approximation to the rationalization of this problem, I assumed that the extent to which we profit by our mistakes is equal to the extent to which we profit by our successes. When these relatively simple psychological ideas are stated symbolically, they take the form of a differential equation whose solution gives a rational equation for the rote-learning function.

Instead of merely fitting a hyperbola with arbitrary parameters to experimentally determined learning records, as I did when I was a student, we are now dealing with an equation whose parameters have meaning in terms of the psychological postulates that the equation represents. The logical manipulation of these postulates leads to some interesting conclusions which must be tested experimentally. Some of these inferences are that the curve for a long rote-learning task should first be positively accelerated and later negatively accelerated. When the task is heterogeneous, the inflection point of the curve should be lower than when the task is homogeneous as to the dispersion of difficulty of its elements. A list of about fifteen such

inferences can be drawn from the postulates and each of them can be tested experimentally. Mr. Gulliksen became interested in this problem and he has investigated logically the consequences of assuming differential rates at which we profit from success and from error. These hypotheses lead to a different set of inferences which are also subject to experimental check.

When we set down a few psychological postulates in the form of a differential equation, the equation is sometimes looked upon as something mathematical, and therefore non-psychological. The equation does not represent a postulate in mathematics. It states a psychological postulate in the concise and universal language of science, namely, mathematics. If the reader does not understand it, he has the same handicap as if the postulate were stated in Russian or in some other language which he can not read. The equation is the statement of a psychological idea.

Every rational formulation of a scientific problem is a challenge to extend its range of application. It should be examined to see what happens when the parameters take limiting values. If the formulation does not make sense at the limiting values, our faith in it must be restricted. By making approximations and adaptations, I arrived at the conclusion that there should be a relatively simple relation between the length of learning time for rote material and the number of items in the lists to be memorized. In fact, the learning time should vary approximately as the 3/2 power of the number of items in the list, irrespective of whether the items are numbers or nonsense syllables. This was an intriguing possibility and, before setting up separate experiments, I searched for available published data. I found nine experimental studies with data for this problem, including the very complete study by Lyons. In all nine of these studies the 3/2 power law was verified. Some of the subjects learned faster than others, and some of the material was intrinsically more difficult than other material, but all the experiments on rote learning verified the 3/2 power law. This is a psychological uniformity that transcends the particular numerical results in each experiment.

A study has recently come to my attention which is encouraging in the application of quantitative rational theory in the field of animal learning. Mr. and Mrs. L. E. Wiley have applied a rational learning function to the learning records of rats, with the special problem of ascertaining whether each animal can be described in terms of a learning constant for a certain type of maze. The mazes are represented in the experiments in five degrees of difficulty. The experiments were done under the general supervision of Professor Lashley. I have examined the preliminary results and I find them to be surprisingly close to the rational learning function.

There is one field of psychology in which quantification has been the rule for many years, and which should therefore have some appraisal in an outline of the objectives of this society. I am referring to the field of psychological and educational tests in which quantitative and statistical procedures have been taken for granted for several decades. No student of psychology can make even a superficial review of the literature in this field without some elementary knowledge of statistical theory. If we take stock of mental testing in relation to the psychological profession as a whole, I believe we must admit that mental testing does not have so much prestige as some other types of psychological work. There is probably good reason for this circumstance. The majority of students in this field are not expected to master the analytical theory of their subject. Too frequently they learn merely the routine of giving various tests, and college credit is given for memorizing this routine. Perhaps it is significant that there is not a single text-book on the theory of psychological tests, although the book market is full of manuals that limit themselves to the description of tests, the routine for giving them, and verbalized interpretations. With increasing attention to the quantitative logic of psychological measurement, it is quite likely that mental testing will be more favorably regarded among psychologists.

One of the old psychological measurement problems is the quantitative description of mental growth. To draw a physical growth curve for stature or for weight is a relatively simple matter when compared with the difficulties of drawing a mental growth curve. In the physical measurement, we have a unit of measurement in the centimeter scale. The application of calipers and tape to each individual is little more than careful routine. But in the measurement of mental growth there was no yardstick previously available and there was no mental unit of measurement. The mental age, or the score in an intelligence test, is logically no more than a tag by which the individuals in a group can be arranged in an ordered series, but that is not measurement. To say that A, B and C have scores or mental ages of 5, 6 and 7, respectively, does not say anything about the relation between the increment A-B and the increment B-C. To say that a person's score on a mental test is zero does not justify the conclusion that he is of zero intellect. Before the mental growth curve could be drawn, the problem of measuring intellect had to be solved.

An ordered series can be transformed into measurement if the frequency function is known. It has been customary to make this transformation on the assumption that a random sample of children has a Gaussian

distribution of intellect at point age, but this assumption has often been questioned because it has not been critically tested until recently. By making this assumption and by allowing only two parameters for each age, to represent mean and dispersion, it was found that there was a linear relation between the absolute variability and the mean test performance for successive age groups. The appearance of this relation led naturally to the definition of an absolute zero of intellect as the value of the mean test performance when variability vanishes. In the nature of the case, variability can not be negative. With these developments and other critical studies of the underlying logic of mental measurement, it is now possible to draw legitimate mental growth functions for the various tests in current use.

Since most available data on psychological tests refer to children of ages five or six and older, there was necessarily a long extrapolation to locate an absolute zero. I have studied similar data for a group of children who were examined monthly or quarterly from birth during the first three years of life. The absolute scaling of these data shows internal consistency. It is of interest to note that the mental growth curve for infants is positively accelerated and that similar studies on older children show the same effect until about eight or nine years of age, after which the mental growth curve is negatively accelerated toward an adult asymptote. One of the most interesting findings concerns the age at which the mental growth curve starts at absolute zero. If we assume that the mental growth curve is continuous below the first month, as it is after that age, then the growth curve starts at absolute zero about four or five months before birth. I have been assured that such a psychological finding is consistent with the normal neurological development of the fetus.

The analytical work of discovering the nature of the abilities involved in psychological tests has been done by Cattell, Thorndike, Spearman, Kelley and by many others who are turning their interests to these problems. The recent extension of Spearman's single factor analysis into any number of dimensions has given a new leverage on this problem, and within a few years we shall have a much better knowledge about the nature of the abilities that can be appraised by means of psychological tests.

Factor analysis is a method of scientific exploration that is not limited to the psychological problem of finding primary abilities. The factorial methods are general, and they can be applied to many different problems that are logically similar. We start with a population of entities that may be individuals, geographic areas, occasions in time or anything else that can constitute the members of a population in the sense of this term in statistical theory. Let each member be known in terms of n attributes. These attributes may be complex and conventional, and they may be overlapping to an unknown extent. It is assumed that we can ascertain the degree of covariation of these attributes. By this we mean that those members who have one attribute to a marked extent may tend to have a certain other attribute also, or the relation may be inverse so that those who have one attribute tend to be noticeably deficient in another attribute. The intercorrelations of the attributes constitute the experimental record of the degree of relation between the attributes.

Given a system of more or less related attributes, the factor problem is to ascertain whether there is some underlying order among them whereby we may be able to comprehend all the n attributes in terms of a smaller number of more fundamental or basic attributes. If such an order can be discovered, and if it can be shown to be unique, then we shall have a very special interest in ascertaining the nature of the smaller number of primary or basic characters which combine to form the larger number of attributes of the system as it is known directly in experience. As scientists, we have the faith that the abilities and personalities of people are not so complex as the total enumeration of attributes that can be listed. We believe that these traits are made up of a smaller number of primary factors or elements that combine in various ways to make a long list of traits. It is our ambition to find some of these elementary abilities and traits. In the mathematical analysis of the problem, it can be shown that the number of basic factors is the minimum rank of the correlational matrix with unknown self-correlations.

All scientific work has this in common, that we try to comprehend nature in the most parsimonious manner. An explanation of a set of phenomena or of a set of experimental observations gains acceptance only in so far as it gives us intellectual control or comprehension of a relatively wide variety of phenomena in terms of a limited number of concepts. The principle of parsimony is intuitive for any one who has even slight aptitude for science. The fundamental motivation of science is the craving for the simplest possible comprehension of nature, and it finds satisfaction in the discovery of the simplifying uniformities that we call scientific laws.

Mathematics is sometimes regarded as a tool or method that can be applied to psychological problems. It is regarded somehow as coordinate with other methods, such as the experimental method and the comparative method. This is just as sensible as it would be to say that theoretical or systematic psychology is a method. The mathematical statement of psychological

postulates and the symbolic representation of fundamental concepts in our science is the natural development of systematic or theoretical psychology which concerns itself with the foundations of our science. In testing psychological theories, stated in quantitative form, we may resort to various experimental methods. But it is hardly correct to say that the invention and development of the theories themselves constitute a psychological method. We shall probably have in our field, as in physics, those who find their talent principally in the analytical study of fundamental concepts and theories, and others who find their best talent in the invention of ingenious experiments for testing psychological theory. The development of our science will probably follow the pattern of all science in becoming more and more mathematical as fundamental ideas become more rigorously formulated.

One of the most fruitful ideas that we can give students is that most of the functional relations in nature are continuous. There are exceptions here and there in which critical values appear with sudden discontinuities, but these are exceptions. Lack of faith in the continuity of natural phenomena is one of the principal handicaps of the student who has not acquired the intuitions of science. Our teaching methods are perhaps largely responsible. Instead of teaching students to compare the first, the second and the third trial of a performance, and the A-group and the B-group in some experiment, we should set up some of our teaching experiments so that the student learns to look for functions rather than discrete comparisons. I shall give a specific example. In studying color vision, the student learns that the maximum saturation of an induced color is produced when the gray value of the background is the same as the gray value of the inducing color. Let this be the object of an experiment with a fixed inducing color. Let the gray value of the background be varied systematically, and let the experimental result be plotted as a continuous curve. It then appears that the maximum saturation of the induced color occurs at the gray value which is equal to that of the inducing color. The student gets the idea that his experiment deals with a functional relation.

We should clarify the distinction between statistics and mathematical psychology. A study can be quantitative without being mathematical. Merely to count noses or the answers in a test or seconds of reaction time or volume of secretion does not make a study either mathematical or scientific. This is not unlike the confusion by which arithmetical labor is sometimes called mathematical. Statistical theory is a branch of logic, and as such it is applicable in all science. If the scientific rationalization of a problem demands a certain relation between parameters or that a certain function should be parabolic or that a certain parameter should have a predetermined value, and if the experimental data have been obtained for testing the hypothesis, then the statistical methods are useful in comparing the agreement between theory and experiment. This is, in fact, the principal usefulness of statistical theory. Hence, a knowledge of statistical theory should be part of the stock-in-trade of every experimental psychologist.

A crucial matter in the development of a psychological science is the training program for the students who are to build this science. The first requisite is some familiarity with basic science, both physical and biological. Without this familiarity the student can hardly be expected to help in building a new science. If he expects to participate in making psychology a quantitative and a rational science, he must know something about the language of science, namely, mathematics. The most profitable study of mathematics is probably done after it has become motivated by a realization that it does function, not merely as an aid or tool that a psychologist can use, but as the very language in which he thinks. It has been my experience that some students who are themselves unable to develop a mathematical idea are nevertheless well able to comprehend an essentially mathematical formulation of a psychological problem with its implications and experimental possibilities. Such a student may be more fertile with ideas than one who possesses considerable mathematical skill without the flexibility of mind that is essential in creative scientific work. More fortunate is the student who has all these aptitudes.

We turn now to what I regard as one of the most fundamental issues in psychological science because it concerns the possibility of such a science. We have considered the desirability of advancing as rapidly as possible, and over an increasing range, to the rationalization of mental phenomena. A rational structure for a psychological science will rest on postulates concerning fundamental psychological concepts. But what shall be the nature of these postulates? Are we willing to build a science on psychological postulates, or shall we demand that psychology develop as a branch of each one of several neighboring disciplines?

In searching for basic concepts for psychology, we must be careful lest we borrow terminology that has prestige and forget to pick up also the ideas that belong with it. This leads to a confident glibness with important-sounding words that is not backed by the understanding which the language is intended to convey. It is not unusual to hear the conversationally minded carry on fluently about relativity and the indeterminacy principle in relation to social and psychological matters even when they know nothing about

these words in their technical setting. When we use a physiological or neurological manner of talking about psychological phenomena, it is well also to take note whether we really have any physiological ideas that are relevant to our problem. We may be convinced that a phenomenon is mediated by a physiological mechanism, but unless we have some physiological hypothesis concerning it, we might as well use the more direct and less pretentious psychological language.

Some rationalizations are regarded as more basic than others. We should like to have a precise physiological description of just what happens when we recall a nonsense syllable in a learning experiment. We should like it even better if the chemical equations could be written that cover the essential effects of recalling the nonsense syllable. Better still would be a detailed account, in terms of mathematical physics, of the molecular and atomic forces that characterize the recall of the nonsense syllable. In this hierarchy, we should gladly supplement a psychological explanation with one that is more basic. It would be unfortunate if the development of any psychological idea should be restricted because of a compulsion to make it look like physiology or to make it look like sociology.

Psychological theory can be rigorous. There is an erroneous impression among psychologists, as well as among our academic neighbors, that psychological ideas are necessarily loose, verbal, subjective and unfit for the quantitative analytical treatment of science. This impression is not justified. It is not necessary for us to abandon psychological concepts if we introduce analytical rigor in dealing with these concepts.

In rationalizing several psychological problems, I have been content to build with psychological concepts and postulates, even though I believe that some of them will be rephrased eventually in terms of physiology or chemistry or physics. But it is my conviction that we shall progress better by frankly building in terms of psychological concepts than by merely adopting a terminology and a manner of work which are premature for many psychological problems. It is better to formulate the laws of learning in terms of psychological ideas, and to find them experimentally verified, than to wait until the phenomena of learning can be rationalized in neurological terms. It may be a long time before that happens, even though we have faith that it will happen eventually. It is better to formulate the law of comparative judgment in terms of the discriminal error, which is a psychological concept, than to wait until we shall understand, physiologically, what happens when we say that one vase is more beautiful than another or that one synonym is better than another or even that one gray is darker than another. Even the simplest sensory comparisons are far from rationalized in physiological terms. If we isolate the primary abilities at first psychologically, perhaps we shall aid in their ultimate identification in physiological terms. I should make the plea that we develop psychological science frankly with psychological concepts, except in those cases where physical, chemical or physiological formulations are available.

In encouraging students to help us build an integrated interpretation of mental phenomena on an experimental foundation, let us remember that a psychological theory is not good simply because it is cleverly mathematical, that an experiment is not good just because it involves ingenious apparatus and that statistics are merely the means for checking theory with experiment. In the long run we shall be judged in terms of the significance, the fruitfulness and the self-consistency of the psychological principles that we discover.

OBITUARY

EDWARD CURTIS FRANKLIN

WITHIN the period of a year, American science has lost three distinguished pioneers in chemical research: Arthur Amos Noyes, on June 3, 1936, Julius Stieglitz, on January 10, and now Edward Curtis Franklin, on February 13, 1937. While they differed widely in personal traits and in the manner in which they applied their talents to the furtherance of research, each, in his own way, left an indelible impression upon American chemistry. Noyes was not a natural experimenter, but he possessed a keen, analytical mind which enabled him to concentrate his attention upon problems that seemed to hold forth promise of important results; his greatest contribution, perhaps, was the organization of two research laboratories and the selection and encouragement of able young chemists. Stieglitz was more the academician of the continental type; his genius found outlet in initiating research in numerous directions, which researches he carried out extensively through collaboration with many graduate students. Franklin was more of a lone worker; he carried on research to satisfy his innate curiosity; he worked in close association with only a few collaborators and the success of these researches was in large measure due to Franklin's consummate experimental skill.

Noyes, Stieglitz and Franklin all began their scientific careers as organic chemists, they all became interested in physical chemistry and made notable contributions to it; Noyes never returned to organic chemistry,

Stieglitz always retained a primary interest in organic chemistry, while Franklin developed a special field and applied to its development his wide knowledge of physical, inorganic and organic chemistry.

Noyes and Stieglitz received much of their scientific inspiration in Germany, where they obtained their degrees—Noyes at Leipzig, in 1890, and Stieglitz at Berlin, in 1889; Franklin was essentially an American product; he was, one might say, a self-made investigator. While he spent a year abroad in 1890–91, there is nothing to indicate that his foreign experience left any great impression on his mind; he spent a year at Johns Hopkins in 1893–1894 and received his doctorate from that institution on the basis of organic research carried out under Remsen. There is some evidence of Remsen's influence in Franklin's later work, but it is not marked. While Noyes and Stieglitz entered upon active research at a very early age, Franklin, who was approximately five years their senior, did not enter upon an active research career until he had reached the age of 35. To understand this delay in Franklin's scientific development, one must be familiar with the background of his early life. In the light of that background, the surprising thing is not so much that he began his research activity so late in life but rather that he began it at all.

Edward Curtis Franklin was born on March 1, 1862, in the little town of Geary City, in Doniphan County, which is located in the northeastern corner of Kansas. He entered the University of Kansas, which had been founded twenty years earlier, at the rather late age of 22; his brother, Will, a year younger, had entered the university a year earlier, and it was largely through his brother's influence that Edward Franklin followed him to the university. Will Franklin became interested in physics and had a notable career as teacher and writer; Edward Franklin took up chemistry, led to this, probably, by his earlier contact with pharmacy. One trait of Franklin's, and one that he never lost, was evident in his student days at Kansas—his capacity for forming friendships. These friendships were lifelong; included among his early intimates were a number of men who later achieved distinction, such as William Allen White, the journalist, and Frederick Funston, one of America's greatest adventurers.

In those early days, of which we are now speaking, the youthful University of Kansas had already achieved a position of some distinction for its researches in biological fields; botany, entomology and, particularly, paleontology. Samuel W. Williston, who had come to Manhattan, Kansas, in early life, from New England, was one of the leaders in research at Kansas; his special field was paleontology. There is little doubt but that the research atmosphere at the University of Kansas in the 80's and 90's was largely due to Williston's influence. In the physical sciences, no active research was carried out at the University of Kansas in those days; this is not surprising when one considers how few were the productive investigators in America at that time. It is not remarkable, therefore, that Franklin, who entered college at an age when students are usually graduating, should have been long delayed in training himself to become an accomplished investigator.

Any one who was not at one of the mid-western universities during the last quarter of the nineteenth century can have no comprehension of the meagerness of the physical facilities. The writer well recalls how Franklin cut up the jackets of Liebig condensers for the purpose of constructing Dewar tubes. Glass, suitable for glass-blowing purposes, was unobtainable in this country; chemicals had to be ordered from Germany and, frequently, had to be made because of the length of time required in obtaining them from abroad. Of the equipment employed in the early work on liquid ammonia, a resistance box and a simple Kohlrausch bridge were the only things that were not homemade.

Franklin hit his stride as an investigator when he began the study of liquid ammonia solutions. The work on liquid ammonia was initiated at Kansas by H. P. Cady with Franklin's encouragement. Later, Franklin and the writer undertook a series of investigations dealing with the problem. The success of the work was due, primarily, to Franklin's superb manipulative skill, which made it possible to successfully carry out measurements with the limited facilities then available. It is interesting to note that many of the results of these early investigations of Franklin's with several collaborators remain to this day almost the only reliable data available. Nothing shows more clearly Franklin's remarkable ability as an investigator than the fact that he was able to plan and carry out physical measurements in a field that had scarcely been cultivated in America at that time and that the results of these measurements have stood the test of forty years.

Franklin was quick to grasp the significance of the results of the experiments with liquid ammonia. He soon saw that a striking parallelism existed between solutions in water and solutions in liquid ammonia. He pressed the analogy further, always devising experiments calculated to establish relations upon a basis of sound fact. He extended and applied his ideas to organic as well as inorganic substances, and with remarkable success. The whole he finally gathered together and published a few years ago in a monograph entitled "The Nitrogen System of Compounds."

As an experimenter, Franklin was unsurpassed. He constructed Dewar tubes as early as 1895, probably the first constructed in America, and he prepared

argon at about the same time and sealed it into Plücker tubes and examined its spectrum. In 1896, he constructed platinum target x-ray tubes to be used by Lucian Ira Blake in his lectures on x-rays; he was ever ready to help a colleague. Franklin enjoyed giving lectures, particularly, when they required difficult demonstrations. He never failed, for example, to prepare nitroglycerine in his lectures on organic chemistry and he delighted in showing what it would do. His lectures on liquid ammonia were something in the way of a work of art; he carried out most difficult reactions in sealed tubes which he carried about with him on his trips. He had the rare ability to present a subject interestingly as well as logically.

If there was one quality of Franklin's that stood out above all others, it was his power of making friends; where others made acquaintances, he made friends. He valued these friendships, and nothing gave him more pleasure than to take a trip through the country to meet again his friends of old or to make new ones.

Franklin was anything but a recluse; he loved social intercourse and gloried in the activities of life. His love of nature was second only to his love of science. Mountain climbing was his favorite recreation and there are few of the higher peaks of the Rockies and the Sierras that Franklin did not climb. In his later years, when climbing mountains was out of the question, his automobile became his out-of-doors friend and companion.

In Franklin were combined many rare qualities that endeared him to his friends; he could be frank without giving offense and he could criticize without provoking rancor, his fair-mindedness was as obvious as his lack of guile and he was generous to a fault. His friends will miss his ready smile and treasure the memories of their happy associations with him.

Vale!

CHARLES A. KRAUS

RECENT DEATHS AND MEMORIALS

DR. EDWARD S. ROBINSON, professor of psychology at Yale University, died on February 24 as the result of injuries received when struck by a bicycle. He was forty-four years old.

DR. RICHARD HOOPE CUNNINGHAM, neurologist and chief of clinic in the neurological department of the Vanderbilt Clinic of Columbia University, died on February 24 at the age of sixty-one years.

PROFESSOR E. S. ERB, for twenty-eight years a member of the department of agricultural chemistry at the Pennsylvania State College, died from a heart attack on February 19 at the age of fifty-nine years.

FREDERIC HEDGE KENNARD, associate in ornithology at the Museum of Comparative Zoology of Harvard University, died on February 24. He was in his seventy-second year.

RICHARD C. RADDATZ, since 1924 general assistant in the department of preparation of the American Museum of Natural History, an expert in mounting animals in habitat groups, died on February 21 in Nairobi, British East Africa. He was about fifty years old. Mr. Raddatz sailed from New York early in January with Mr. and Mrs. Philip M. Plant to collect specimens of wart hogs and ostriches for the Carl Akeley animal groups in the museum.

CRANDALL Z. ROSECRANS, assistant director and chief of the metallurgical division of the Leeds and Northrup Company, Philadelphia, died suddenly on January 7 at the age of forty years.

Nature reports the death of Professor Michael Lenhossék, emeritus professor of anatomy in the University of Budapest and president of the Hungarian Academy of Sciences, an authority on the histology of the nervous system, on January 26, aged seventy-three years, and of Dr. F. Sowerby Macaulay, known for his mathematical work, on February 9, aged seventy-four years.

THE following minute was drawn up by the Wistar Institute of Anatomy and Biology, Philadelphia, on the death of Effingham Buckley Morris: "From a long and active life in law, in finance and in the promotion of science Effingham B. Morris on January 22, 1937, passed forever from scores of devoted friends and admirers in all walks of life. To his associates in financial circles he was known for his integrity and vision in the management of affairs of magnitude; to those who knew him as a promoter of scientific knowledge he was admired for his resourceful efforts in building the institutions he administered; to those whose privilege it was to know him intimately he engendered a love and respect without limit. Members of the staff and employees of The Wistar Institute mourn the loss of a real friend; a member of the board of managers since 1915 and president of The Wistar Institute since 1922."

SCIENTIFIC EVENTS

THE COLUMBIA UNIVERSITY SCHOOL OF MEDICINE

GIFTS received by the Columbia University School of Medicine will enable it to advance its program of graduate medical education by enlarging its laboratory facilities at a cost of $500,000. Eight floors will be added to the west wing of the building of the School of Medicine at the Medical Center. The new construc-

tion is designed to house the graduate laboratories of the departments of anatomy, pathology, biological chemistry, physiology and bacteriology.

In discussing the plans of the school Dean Willard C. Rappleye said in part:

After full consideration of the great importance to the medical profession, the hospitals and the public of establishing graduate medical education at a high university level, the trustees of the university in 1932 created a higher degree to identify the individual who obtains that recognition as qualified by a university grade of training in one of the specialized fields of clinical medicine. A single level of graduate medical education is recognized for this purpose. Only residents appointed in one of the affiliated hospitals are eligible for registration for the degree of Doctor of Medical Science (Med.Sc.D.).

The new laboratories will provide the facilities for the necessary advanced work in the medical sciences. This work may be taken previous to the residency or be carried during the hospital period, if that can be arranged.

Affiliations with approximately twenty leading hospitals of the metropolitan area make available ample facilities for advanced clinical training and secure the participation in the program of a number of the outstanding clinicians of the vicinity.

The program conforms to the standards adopted in 1934 by the Council on Medical Education and Hospitals of the American Medical Association, and the Advisory Board for Medical Specialties, the latter representing the American Hospital Association, the Association of American Medical Colleges, the Federation of State Medical Boards of the United States, the National Board of Medical Examiners and the twelve national boards of specialists dealing with graduate medical education and certification.

Seven requirements for the advanced degree of doctor of medical science were listed by Dr. Rappleye. These are: graduation from a medical school approved by the university; completion of an internship of not less than one year in a hospital approved by the university; a three year period of study after the internship in the university or in approved hospitals and laboratories; intensive training in one or more of the basic medical sciences related to the special field of study selected; active experience during the three year period of not less than eighteen months in the hospital, clinics and diagnostic laboratories of the specialty selected; written, oral and practical examinations in the specialty elected and in related fields, and "an acceptable dissertation on an investigation conducted in or closely related to the specialty elected."

THE ELECTRONICS INSTITUTE AT THE UNIVERSITY OF MICHIGAN

AN Electronics Institute, consisting of a special lecture and conference program in electronics, will be held in Ann Arbor, as a part of the 1937 Summer Session of the University of Michigan, with the cooperation of members of the technical staffs of the General Electric Company, the Westinghouse Electric and Manufacturing Company and the Bell Telephone Laboratories.

The lectures will be given by Dr. Saul Dushman and Dr. Lewi Tonks, of the General Electric Research Laboratories; Dr. H. E. Mendenhall and Dr. F. B. Llewellyn, of the Bell Telephone Laboratories; Dr. Joseph Slepian and Dr. R. C. Mason, of the Westinghouse Research Laboratories; Professor Leonard B. Loeb, of the University of California, and Professor W. G. Dow, of the University of Michigan.

The program will consist of two independent four-weeks lecture sequences, dealing respectively with high-vacuum (June 28 to July 24) and gaseous-conduction electronic principles (July 26 to Aug. 20). In parallel problem laboratory and conference courses the lecture material will be worked into illustrative engineering problems, and teaching methods will be demonstrated and discussed. Opportunities for informal conferences will be provided. Courses in various cognate branches of electrical engineering, physics and mathematics will be included in the program.

The primary objective of the institute is to provide an opportunity for teachers and prospective teachers of electronics, engineers and physicists engaged in electronic development work in industry, and graduate students interested in electronics to broaden and unify their grasp of fundamental principles. It is believed that this opportunity for association between teachers and leaders in electronic research and development in industrial laboratories will help to clarify methods and policies in the teaching of the subject in engineering schools.

A special bulletin describing the details of the program is being prepared and can be obtained from Professor W. G. Dow, Electrical Engineering Department of the University of Michigan.

THE WISCONSIN ALUMNI RESEARCH FOUNDATION

THE University of Wisconsin Alumni Research Foundation, which was established in 1925, has appropriated the sum of $163,000 to the research funds of the university for the coming year for the support of both old and new research projects which are carried on under the direction of faculty members. All the projects, about eighty in number, are selected and approved by the University Research Committee, and the foundation which provides the funds has no voice in the selection or in the policies to be followed in carrying out the research work. This year's grant represents an increase of $20,500. It brings the total amount given by the foundation to research in the natural sciences during the last nine years to $83,033.

Of the total amount appropriated for the coming year, $100,000 is allotted to special grants-in-aid to stimulate university research. These are used to purchase equipment and supplies and to help to support

more than a hundred graduate research workers, thus enabling them to carry on their own research at the same time. Included in the grant again this year is an appropriation of $17,000 to permit faculty members to carry on during the summer certain lines of research which are already under way.

Funds are again included for the continuation of special fellowships and scholarships and for several post-doctorate fellowships. $20,000 is appropriated for the special fellowships and scholarships which were inaugurated two years ago. Known as the Wisconsin Alumni Foundation fellowships, these special fellowships and scholarships are granted to the most gifted young scholars and scientists that can be found in the United States.

The sum of $7,500 is included in this year's grant for the continuation of several post-doctorate fellowships with which it will be possible to bring to the state university unusually gifted men who have already proved their ability to carry on independent research work in the natural sciences.

A new item in the allotment is a fund of $10,500 for the establishment of a "University Press." The establishment of the University Press does not mean that the university will engage in the printing business, but merely means that funds of the press will be used to publish pamphlets and books on scientific and educational reports of the university, and that all such publications will bear the stamp, "The University of Wisconsin Press."

The grant also includes $8,000, which will provide for the continuation of the work now being done by Professor Aldo Leopold on game management and land-waste problems in connection with the university arboretum. Dr. H. L. Russell, director of the foundation, in a statement recently issued said:

> When it is realized that this organization started only ten years ago with no capital other than a single application in the U. S. Patent Office; that in this period of time it has built up a list of sixteen patents, not only in the United States and Canada, but in foreign countries as well; that it has developed a business organization with permanent offices in Madison, Chicago and New York, and has created an investment portfolio capable of yielding as interest over $160,000 this year, it is apparent that this method of handling university patentable ideas is being worked out in a unique way at the University of Wisconsin.

MEETING OF TEXAS GEOLOGISTS

THE Southwestern Geological Society, the Bureau of Economic Geology and the Department of Geology of the University of Texas were hosts to the geologists of Texas and adjacent states on February 13. A preliminary meeting was held at the Stephen F. Austin Hotel on Friday evening, at which the leaders of the three field trips briefly outlined the area to be covered. These were as follows: One to the central mineral region under the leadership of Dr. H. B. Stenzel; one to the Cretaceous in the vicinity of Austin under the direction of Professor F. L. Whitney, and one to the lower Tertiary to the east of Austin led by Dr. R. H. Cuyler. Approximately one hundred and forty geologists attended the various field trips.

Following the field trips, dinner was served at the University Commons. At the dinner Dr. H. Y. Benedict, president of the University of Texas, spoke briefly of his student days at the university under Dr. R. T. Hill, first professor of geology, and Dr. F. W. Simonds, Dr. Hill's successor. Both Dr. Hill and Dr. Simonds were guests at the dinner. At the close of Dr. Benedict's talk, portraits of both Dr. Hill and Dr. Simonds were presented to the department of geology to be hung in the seminar room of the geology building. Following the presentation of the portraits, Dr. Parker D. Trask, a graduate of the University of Texas, spoke on "Source Beds of Petroleum." Dr. Trask is an associate geologist with the United States Geological Survey and has been identified with the National Research Council in an investigation of the source beds of petroleum. Following his address the visiting geologists were conducted through the geology building and were entertained at an informal reception by the faculty and students.

FOSTER LECTURE FOUNDATION AT THE UNIVERSITY OF BUFFALO

MRS. ORRIN E. FOSTER, of Buffalo, has established and endowed as a memorial to her husband at the University of Buffalo a permanent lecture foundation in chemistry and allied sciences.

Long-time friends of the university, Orrin E. Foster and his family were the donors of Foster Hall, which was the first new building to be erected on the North Main Street Campus. The hall was dedicated on October 27, 1922, in connection with the inauguration of Chancellor Capen as head of the university. It has served as a laboratory for students of chemistry and pharmacy.

Since income from the new gift is now available, plans have been completed to inaugurate the foundation at once, with a series of public lectures, beginning in March. Four of the lecturers and their subjects are as follows:

March 18, Dr. Karl K. Darrow, of the Bell Telephone Laboratories of New York City, "Atoms and Elements."

March 23, Dr. Marston T. Bogert, professor of chemistry at Columbia University, "Around the World in Search of Perfumes."

April 6, Dr. Frank C. Whitmore, dean of physical sciences at Pennsylvania State College and president-elect of the American Chemical Society, "What Do the Organic Chemists Really Know?"

May 4, Dr. R. A. Gortner, chief of the Division of Agricultural Biochemistry at the University of Minnesota, "Recent Advances in Chemistry in Relation to Agriculture."

Speakers each year will be chosen by a Foster Lecture Committee composed of five members appointed by the chancellor. Members of the committee, who have just been appointed, are as follows: Dr. Groves H. Cartledge, head of the department of chemistry at the university, *chairman;* Dr. Harold G. Hewitt, assistant professor of chemistry; Dr. David F. Smith, professor of chemistry; Dr. Wilson D. Langley, associate professor of bio-chemistry; Dr. Preston Hoff, manager of chemical research at the du Pont-Rayon Research Laboratories in Buffalo.

THE INSTALLATION OF A CHAPTER OF SIGMA XI AT THE GEORGE WASHINGTON UNIVERSITY

AT the winter convocation of the George Washington University on February 22 a chapter of the Sigma Xi was installed. Dr. Edward Ellery and Dr. G. B. Pegram, who are national officers of Sigma Xi, conducted the exercises. Dr. Paul Bartsch, president of the petitioning group at the George Washington University, read the petition. Dr. Ellery presented the charter of the new chapter to its secretary, Dr. Paul Bowman, assistant professor of biology in the university. Dr. Pegram delivered the charge to the new chapter.

Forty-three members of the university faculty who were members of Sigma Xi chapters at universities where they took their degrees, and who formed the petitioning group, are charter members of the chapter. Fifty members have been elected. Delegates representing thirty-one chapters of the Society of the Sigma Xi in colleges and universities throughout the country were present at the convocation. Three hundred and fifteen students were graduated from the various colleges and schools of the university.

The convocation address was delivered by Dr. William Alanson White, professor of psychiatry at the George Washington University and superintendent of St. Elizabeth's Hospital. He spoke on "The Function of Education as Viewed from the Standpoint of the Present World Crisis."

At the ceremonies honorary degrees were conferred, President Marvin reading the following citations:

DOCTORATES OF SCIENCE

CHARLES GREELEY ABBOT: Persistent and courageous investigator in the field of astrophysics, in whom scientific thinking and religious reflections are not separated; secretary of the Smithsonian Institution.

PAUL BARTSCH: Eager scientist; teacher; quick to appreciate human values; who, for years, has devotedly served in the George Washington University.

WILLIAM BOWIE: Graduate of Trinity College (Connecticut); cheerful colleague and tried friend of those who seek for truth; to whom long experience in scientific endeavor has brought recognized leadership.

LYMAN JAMES BRIGGS: Sincere scholar and worthy public servant, in whom firmness of conviction and tolerance toward the beliefs of others go hand in hand; chosen to direct the Bureau of Standards.

GEORGE BRAXTON PEGRAM: Son of the South; well known investigator and expounder of physical sciences; worthy servant of Columbia University; acting-president of the Society of the Sigma Xi.

DOCTORATES OF LAWS

EDWARD ELLERY: Teacher, administrator and man of science, skillful in encouraging scientific endeavor, general secretary of the Society of Sigma Xi.

JOHN CAMPBELL MERRIAM: Master in the field of paleontology, painstaking leader in scientific investigation, philosopher and man of letters; devoted to the principles of natural law and fully cognizant of their application in the life of to-day; president of the Carnegie Institution of Washington.

WILLIAM ALANSON WHITE: Productive scholar, devoted teacher, enlightened executive, able to make knowledge a saving power in the lives of men; to know him is to desire his friendship.

SCIENTIFIC NOTES AND NEWS

DR. EJNAR HERTZPRUNG, director of the University Observatory at Leiden, has been awarded the Catharine Wolfe Bruce Gold Medal for 1937 of the Astronomical Society of the Pacific. He has also been appointed to the newly established Alexander F. Morrison memorial research associateship in the Lick Observatory.

DR. SELMAN A. WAKSMAN, professor of soil microbiology at Rutgers University, has been elected a corresponding member of the Academy of Sciences, Institute of France. He fills the place in the section of rural economy vacant by the death of Sir Arnold Theiler.

DR. A. N. WINCHELL, professor of mineralogy and petrology at the University of Wisconsin, and Dr. Douglas Johnson, professor of physiography at Columbia University, have been elected corresponding members of the Geological Society of China, Nanking.

DR. WILLIAM BERRYMAN SCOTT, professor of geology, emeritus, at Princeton University, celebrated his seventy-ninth birthday on February 12.

DR. HOWARD A. KELLY, professor of gynecology, emeritus, at the Johns Hopkins University, the only surviving member of the group that was instrumental

in the founding of the Medical School, celebrated his seventy-ninth birthday on February 20.

The Western New York Section of the American Chemical Society has awarded the Jacob F. Schoellkopf Medal for 1937 to James G. Marshall, general superintendent of the Niagara and Welland plants of the Union Carbide Company and the Electro Metallurgical Company, in recognition of his "technical contributions to the calcium carbide and ferro-alloy industry, his untiring efforts in behalf of civic betterment and his unceasing interest in the improvement of working conditions." Formal presentation of the medal will be made early in October.

Professor J. R. Shank, assistant director of the Engineering Experiment Station of the Ohio State University, received the Research Medal of the American Concrete Institute for his article entitled "The Plastic Flow of Concrete" at the annual dinner of the institute on February 26. This medal is awarded for the best research published in the proceedings of the institute during the year.

The Alvarenga Prize for 1936 of the College of Physicians of Philadelphia has been awarded to Dr. Harry Eagle, passed assistant surgeon, U. S. Public Health Service, who is at present stationed at the Johns Hopkins Hospital. Dr. Eagle's Essay, "The Present Status of the Blood Coagulation Problem," will be published in a forthcoming issue of *Medicine*.

Dr. Clarence J. West, technical editor at the Institute of Paper Chemistry affiliated with Lawrence College, Appleton, Wis., was presented with the gold medal of the Technical Association of the Pulp and Paper Industry at a luncheon given at the Waldorf-Astoria Hotel, New York City, on February 24. The presentation was made by Dr. Harry F. Lewis, dean of the institute and a member of the Technical Association. The medal was awarded to Dr. West for his work in the bibliography of technical and scientific literature dealing with pulp and paper.

Dr. Henry Dwight Chapin, professor emeritus of pediatrics at the New York Post-Graduate Medical School and Hospital, was the guest of honor at the annual dinner of the Faculty Association of the school on January 23. The occasion celebrated the fiftieth anniversary of Dr. Chapin's appointment as professor of pediatrics and his eightieth birthday, which was on February 4. The speakers at the dinner included Drs. Arthur F. Chace, president of the board of directors; Frederic E. Sondern, formerly president of the Medical Society of the State of New York; Adolph G. G. De Sanctis, president, and Walter T. Dannreuther, formerly president, of the Medical Society of the County of New York, and Charles Gordon Heyd, president of the American Medical Association. The Faculty Association presented to Dr. Chapin a silver loving cup.

Dr. George W. McCoy has been relieved as director of the National Institute of Health, effective on January 31. He had held the position since 1915, when the institute was known as the Hygienic Laboratory. It is reported that he will be assigned to investigations on leprosy.

Dr. Raymond Pearl, professor of biology in the School of Hygiene and Public Health at the Johns Hopkins University, has been appointed Heath Clark lecturer for the year 1937 at the University of London.

Dr. Ronald George Wreyford Norrish, Humphrey Owen Jones lecturer, has been appointed to succeed the late Professor T. M. Lowry as professor of physical chemistry at the University of Cambridge.

At the University of London the title of professor of biochemistry has been conferred on Dr. A. C. Chibnall, in respect of the post held by him at the Imperial College, Royal College of Science, and the title of emeritus professor of mining geology has been conferred on Dr. C. G. Cullis, on his retirement from the university professorship of mining geology at the Imperial College, Royal College of Science.

Dr. Adolf Butenandt, professor of organic and biological chemistry at Danzig, has been made director of the Kaiser Wilhelm Institute for Biochemistry at Berlin-Dahlem.

Edwin H. Colbert, of the American Museum of Natural History, New York, has become associate curator of the department of geology and paleontology of the Academy of Natural Sciences of Philadelphia.

Dr. John C. Hostetter, who had charge of the construction of the 200-inch telescope mirror at the Corning Glass Works, has been made vice-president of the Hartford Empira Company, Connecticut.

Dr. D. R. Pye has been appointed director of scientific research in the British Department of the Air and member for research and development in the air ministry, to take the place of H. E. Wimperis. W. S. Farren has been appointed deputy director of scientific research in succession to Dr. Pye.

Dr. Harry Sobotka, chemist to the Mount Sinai Hospital, New York City, and Dr. Louis J. Soffer have received a grant-in-aid from the Committee on Scientific Research of the American Medical Association for the study of lactic acid tolerance in hepatic disease.

The Rockefeller Foundation has made a grant of

$3,000 to Professor Elizabeth Adams, of Mount Holyoke College, to be used during 1937 and 1938 for work on the endocrine glands.

DR. A. A. DUNLAP, assistant mycologist and plant physiologist at the Connecticut Agricultural Experiment Station at New Haven, has been granted leave of absence for four months for research to be carried out at the Johns Hopkins University on the sand culture of seedlings.

DR. PAUL WEISS has leave of absence from the University of Chicago from April 1 to October 1. He expects to continue his study of the nervous system in several European laboratories, principally at the laboratory of Professor Bremer in Brussels. The Rockefeller Foundation is sponsoring his work.

DR. SYDNEY W. BRITTON, professor of physiology in the University of Virginia, has left for Panama for a two-months study of the wild animals of the Central American jungles. He is accompanied by the curator of the expedition, William Atkinson, and by Raymond F. Kline, research assistant. Two months will be spent at the Barro Colorado Laboratory, maintained on an island in Gatun Lake by Harvard University, the National Research Council and other organizations. While he is in the Canal Zone Dr. Britton has been invited to speak before the Society of Natural History of the Panama Canal.

THE Institute for the Study of Malaria at Rome, of which Professor G. Bastianelli is director, has sent a mission to Abyssinia to study various aspects of malaria. Members of the mission include Professor G. Lega, pathology and clinical medicine, and Professor G. Raffaele, entomology, epidemiology and prophylaxis.

DR. F. A. VENING MEINESZ, president of the International Geodetic Association, lectured on "Gravity on the Atlantic Ocean" on February 16, before a joint meeting of the Society of Sigma Xi, District of Columbia Chapter, the Geological Society of Washington and the Washington Academy of Sciences.

DR. HENRY E. SIGERIST, director of the Institute of the History of Medicine at the Johns Hopkins University, gave a Mayo Foundation lecture on "The History of the Concept of Disease" at Rochester, Minn., on February 26.

DR. GEORGE H. WHIPPLE, dean of the School of Medicine and Dentistry at the University of Rochester, will deliver the fourth annual Alexander Van Rensselaer lecture at the Drexel Institute of Technology on the evening of April 15. He will speak on "Blood Hemoglobin Production within the Body as Influenced by Diet and Other Factors under Experimental Conditions."

DR. T. WINGATE TODD, professor of anatomy at the School of Medicine of Western Reserve University, gave the first annual Clarence J. Grieve Foundation lecture on March 1. He spoke on "Facial Growth and Pharyngeal Health."

DR. WILLIAM T. M. FORBES, professor of entomology at Cornell University, gave on February 19 an address entitled "Butterfly Geography" before the Royal Canadian Institute, Toronto.

DR. RICHARD P. STRONG, professor of tropical medicine at the Harvard Medical School, delivered the first Chadwick Lecture of the Royal Society of Tropical Medicine and Hygiene, London, on January 21. His subject was "Onchocerciasis in Central America and Africa." Dr. Strong was recently elected an honorary fellow of the society.

DR. HARLAN T. STETSON, research associate at the Massachusetts Institute of Technology, gave on February 16 the first lecture in the Springfield, Mass., Public Forums Series entitled "Recent Developments in Science." The title of Dr. Stetson's lecture was "The New Universe."

J. G. CROWTHER, London, scientific correspondent of *The Manchester Guardian,* will give a series of public lectures on "The History of American Science," at Harvard University, during the first two weeks of March.

DURING the next five months Mills College, the second oldest college for women in America, will celebrate the eighty-fifth anniversary of its founding. The School of Science will be charge of the program for the month of March, while the various other schools of the college will plan the commemorative events for the other months. Among those who will take part are Dr. Robert Grant Aitken, emeritus director of Lick Observatory; Dr. Knight Dunlap, professor of psychology at the University of California at Los Angeles, and Dr. E. O. Lawrence, director of the Radiation Laboratory at the University of California.

THE seventeenth International Congress of Agriculture will be held from June 16 to 23 at the Hague.

The fourth International Congress on the History of Science will be held in Prague from September 22 to 27, under the presidency of Professor Quido Vetter. Papers will be discussed dealing with the development of the sciences during the eighteenth and first half of the nineteenth centuries, the history of science in education and other historical subjects. The one hundred and fiftieth anniversary of the birth of Jan Evangelista Purkyně (or Purkinje), the distinguished Czech biologist, will be celebrated during the congress.

THE fourteenth National Colloid Symposium will meet at the University of Minnesota on June 10, 11

and 12. Professor Herbert Freundlich, of University College, London, will be the guest speaker and will open the symposium. It is planned to hold the sessions in the Chemistry Building of the university on June 10 and 11, and then to drive to Rochester where the papers of the last day will be given at the Mayo Clinic. The sessions there will be devoted to papers of a bio-colloidal nature. Opportunity will be given to spend some time in visiting the Clinic Building and the research laboratories connected with the Mayo Foundation. The program for the symposium is rapidly being filled and it is suggested that authors, wishing to have papers considered for the meeting, should write at once to Professor H. B. Weiser, The Rice Institute, Houston, Texas. The local committee making arrangements for the symposium consists of D. R. Briggs, Geo. Glockler, R. A. Gortner, I. M. Kolthoff and L. H. Reyerson, chairman.

THE attention of scientific workers is called to the Theobald Smith award established by Eli Lilly and Company and approved by the council of the American Association for the Advancement of Science at the Minneapolis meeting. The conditions of the award as recommended by the executive committee after study of the situation and as adopted by the council are given in SCIENCE for July 26, 1935, p. 75. Members of the committee of award for 1936–37 are: Drs. Edwin G. Conklin, *chairman;* Anton J. Carlson, Howard T. Karsner, Chauncey D. Leake and Hans Zinsser. This committee will serve until it reports at the Denver meeting. By request of the committee and with the approval of the council all correspondence in the matter should be addressed to the Permanent Secretary and not to the individual members of the committee.

THE National Research Council announces that in the administration of its fellowships in the natural sciences, consideration will be extended to applications for fellowships of post-doctorate grade for the coming year in the fields of geology, paleontology and physical geography. The basic stipend will be $1,600 per year. Requests for application blanks should be addressed to the Secretary, National Research Fellowships Board in the Natural Sciences, National Research Council, 2101 Constitution Avenue, N.W., Washington, D. C. Applications to be considered should be returned to the Research Council by April 1.

AT the recent Atlantic City meeting both the Ecological Society of America and the American Society of Zoologists passed resolutions condemning the so-called "vermin" campaigns that are destroying some of our most interesting animals by the hundreds of thousands. The former society appointed one of its members to write certain articles for publication and wide distribution to call the attention of those interested in nature to what is being done.

SOIL survey reports and maps are in great demand and in many instances all available supplies are exhausted. Dr. Henry G. Knight, chief of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, urgently requests that any one having copies of these reports for which they have no further use send them to the bureau for distribution to people needing them. Upon request Government blanks will be forwarded for the purpose.

E. L. PACKARD, of Oregon State College, writes that the Oregon State Board of Higher Education has announced the establishment of the Institute of Marine Biology at Coos Head, on an eighty-five acre tract acquired for the purpose from the Federal Government through Congressional Acts of 1931 and 1935. Preliminary studies are said to indicate an abundant and diversified fauna and flora within the waters of Coos Bay and that the life of the open ocean shows a mingling of both northern and southern forms. The extensive marine fisheries include the salmon and the pilchard centering in this region, and the industries based upon crabs, clams and oysters afford many opportunities for basic researches in these fields. This station is organized to serve all the institutions of the State System of Higher Education of Oregon, and cooperatively others within the state and elsewhere, as a center of biological research relating primarily to the life of the sea and as a training ground for future biologists and teachers of biology.

DISCUSSION

DISSEMINATION OF SCIENTIFIC LITERATURE BY MEANS OF MICROFILMS

BECAUSE of the rapidly increasing volume of scientific literature, its classification and dissemination to those who use it is becoming an ever increasingly complex and costly problem. Aid of this character to research is usually rendered by means of abstract journals, but these require the cooperation of many persons, and their publication is very expensive.

It is believed that microfilms may serve both to supplement existing abstracts and, in cases where necessary, provide a more economical means of acquainting scientists with the work of others.

Although abstract journals enable the research worker to learn what papers have been published upon a given problem, they can give but few details in regard to each research. It is, therefore, usually necessary to consult the original paper, and this may be done only by those having access to well-stocked special libraries.

Another manner of acquainting workers with the literature of their subjects is by the publication of classified catalogues of the titles of scientific papers appearing in the journals of the world. Although the title alone certainly gives less information than can be included in an abstract, it is a question whether such additional information is really worth its far greater cost. Those concerned with furnishing such service to research workers are faced with the question as to whether, at an approximately equal expenditure of effort, it is preferable to provide a completely classified catalogue of the titles of scientific papers in a given field or abstracts of only those papers selected as worthy of the attention of research workers. A decision of this question will be influenced by the availability of the original papers to those who need them. Certainly no one who can consult the original paper would be content with the abstract; consequently it may be expected that a service which provides a highly classified list of scientific papers and also furnishes at very low cost photographic copies of the original papers themselves will be preferred by many to even the most perfectly organized abstracting service.

Thanks to the perfection in recent years of apparatus for the production and reading of microfilms, it is suggested that such equipment may be adapted to providing the kind of complete service to research workers mentioned above.

The organization of a service of this kind, based on microfilms, falls into two divisions: that of providing a classified and indexed catalogue of titles of papers and that of furnishing microfilm copies of the papers themselves. The establishment of such a service would also result in the gradual accumulation of complete microfilm collections (filmothecs) of scientific literature. In this connection, the question arises as to whether it is preferable to develop services and build up collections in the separate branches of science, or undertake the organization of a single all-embracing service and filmothec of science. Due to the immensity of the latter plan, it seems preferable to confine attention at this time to filmothec service in single branches of science.

Even in the most restricted field of research, and certainly in the larger ones, it would first be necessary to establish subclasses of the subject. These would be given abbreviated distinctive descriptions as well as numerical (decimal) designations. A widely published key to these descriptions and corresponding numerical designations might eventually make it possible to rely exclusively upon the numerical classification just as is done at present in the arrangement of books upon the shelves of libraries in accordance with the Library of Congress classification.

In the operation of a "Filmothec Service," there would be required only such trained scientists as would be needed to assign correct classifying designations, and choose the best indexing words for the original papers published in the current scientific periodicals. When this was done and the corresponding numerical designations and indexing words stamped on or affixed to each article, all other steps in the process could be executed by persons without special technical knowledge.

The current journals, after having their constituent original articles provided with the classifying designations, would be delivered to the photographic laboratory and each article successively photographed with its identification numbers and indexing words. The finished band bearing these microfilm copies would then be cut in lengths corresponding to each separate article. These individual microfilm strips would be filed in appropriate folders, each bearing the designation of the subclass and having serially arranged pockets to receive the serially numbered individual strips. By this means the articles in a particular branch of science would automatically be collected together and serially numbered. When a given folder was filled or at such periods of time as chosen, the titles and designation numbers of the articles in each folder would be typewritten in their regular numerical order, and an index of the selected words of each title prepared. These typewritten copies of the contents of each folder would be assembled and prepared for distribution to research workers in whatever form was most economical. For a very large and active branch of science, these lists would undoubtedly be printed and distributed in editions of many thousands. For more restricted fields of research, the lists might be reproduced by offset printing or even by duplicating machines.

By means of these highly classified lists of titles of articles which would be indexed in accordance with the particular subject treated in each article, the individual worker would be able to choose those articles which he considered of most interest to him. To obtain copies of these, he would only have to send the designating numbers of the articles he desired to the office in which the master microfilm copies were on deposit. Upon receipt of such orders, the desired original microfilm strip would be removed from the folder and sent to the photographing laboratory for making positive film copies of the original, or enlarged photoprint copies, if preferred. This process is extremely simple

and can be carried out at considerably less cost than making the photographic copy direct from the journal. The positive copies thus made would be sent to those requesting them, and the master negative returned to its proper pocket in the folder in which it is kept.

In the above brief outline of the general organization of a Filmothec Service, it has not been possible to go into detail in regard to the several mechanical operations. The experience so far gained, however, with microfilm cameras shows that no serious difficulties may be expected. It is simply a question of the systematic organization of the work and the application of ordinary ingenuity in perfecting systems of identification markings for the film strips and properly constructed folders for filing and preserving the master negatives.

The technical directions necessary and the cost of making the original microfilms by directly photographing the periodicals should not greatly exceed the cost of preparing the card catalogues of original papers which would be necessary as the basis for the preparation of catalogues of scientific literature. The cost of making positive copies from negative microfilm strips is certainly far less than making microfilm copies directly from the journals.

This plan also has the advantage that complete filmothecs of scientific literature would be gradually built up, and with succeeding years, there would be a greatly increased amount of literature of which positive copies of desired papers could be supplied at an exceedingly low cost.

The one objection which may be offered is that no one library receives all the journals which must be consulted in the preparation of complete catalogues of titles of papers in a given field of science. Although this is true, there has developed such a spirit of cooperation between American libraries that by choosing two or three of the most important, and setting up microfilm cameras in these, the few journals which would still be necessary could probably be secured by loan or by purchase. Furthermore, this is a plan which lends itself especially well to making collections and disseminating literature for the benefit of research workers in very restricted branches of science. There are, for example, certain very special journals which, in addition to publishing original articles in their fields, also furnish abstracts of papers published elsewhere. This is, of course, a distinct service, but certainly of considerably less value than would be the providing to their subscribers of microfilm copies of the original articles chosen for abstracting.

It is evident that the suggested plan of using microfilms for the dissemination of scientific literature is capable of first being tested on a very limited scale, and if its value is demonstrated by such experience, may be expanded as rapidly as the results justify. It offers possibilities which are worthy of serious consideration by those concerned with the more perfect utilization of scientific literature.

ATHERTON SEIDELL
NATIONAL INSTITUTE OF HEALTH
WASHINGTON, D. C.

MICRO-PHOTOGRAPHY OR PHOTO-MICROGRAPHY?

RECENT issues of SCIENCE have brought suggestions on scientific nomenclature and the use of English. In this connection I would suggest for relegation to oblivion that horrible hybrid "photo-micrography." I have never been able to see the reason for coining this cacophonous misnomer—surely the term micro-photography is descriptive enough. One shudders to think what would happen if the precedent set by photomicrography were followed consistently: we should then have to drop color photography and celestial photography in favor of photo-chromography and photo-uranography. If we sanction photo-micrography astronomers will be at a loss to know whether chronograph refers to an instrument used in measuring time or to a picture of Saturn, and we may, perhaps, look forward to the day when the studio photographer who specializes in portraits will announce himself as an expert in photo-prosopography.

W. J. LUYTEN
UNIVERSITY OF MINNESOTA

A VASOPRESSOR LOCAL ANESTHETIC

DR. RAYMOND L. OSBORNE and his associates are to be congratulated for the successful synthesis of a vasopressor local anesthetic, as described in SCIENCE, (85: 105, January 22, 1937). A brief historical account is included in the report. The reasons are given for attempting the synthesis of a chemical agent which combines the local anesthetic actions of the alkamine esters of para-amino benzoic acid with the vasoconstrictor effects of the phenylethylamines. Since the report does not refer to any other attempts to synthesize such a compound, it gives the impression to the uninformed that it is the first report on this matter to appear in scientific literature. This is unfortunate. Other efforts, more or less successful, of this same sort have been made by Kubota,[1] Takeda,[2] Hartung, Munch and Kester,[3] and in a particularly exhaustive manner by Alles and Knoefel.[4] The latter discuss 29 compounds of this type which were deliberately prepared

[1] Kubota, *Jour. Pharm. and Exp. Ther.*, 12: 361, 1919.
[2] Takeda, *Jour. Pharm. Soc. Japan*, No. 426, 691, 1917, through *Chem. Abs.*, 11: 3241, 1917.
[3] Hartung, Munch and Kester, *Jour. Amer. Chem. Soc.*, 54: 1526, 1932.
[4] Alles and Knoefel, *Arch. Internat. Pharmacody. Ther.*, 47: 96, 1934.

to accomplish the purposes described by Osborne. These drugs were studied in a thorough way in order to determine which of the group would be most satisfactory for clinical trial. One of these vasopressor local anesthetics of Alles and Knoefel, β-benzoyloxy-β-phenyl-ethyl-demethylamine hydrochloride, came to clinical use and was reported upon by E. W. Ferber.[5] The purpose of this present note is not to detract from the merit of the report of Dr. Osborne and his associates. It does seem, however, that his statement in SCIENCE would have given a more correct impression had it referred to previous work of the same character.

CHAUNCEY D. LEAKE
PHARMACOLOGICAL LABORATORY
UNIVERSITY OF CALIFORNIA
MEDICAL SCHOOL

THE ACTION OF ESERINE AND ITS ANALOGUES ON SKELETON MUSCLE

IN SCIENCE for December 18, 1936, p. 551, Morison and Rosenblueth deal with the cause of their earlier failure (Rosenblueth, Lindsley and Morison)[1] to detect the potentiating effect of eserine and its analogues on the response of a mammalian muscle to a motor nerve volley. Brown, Dale and Feldberg[2] had suggested that the anesthetic might have been responsible for the absence of this action in Rosenblueth, Lindsley and Morison's experiments; but Morison and Rosenblueth have now found that the length of the interval between successive motor nerve volleys is a much more important factor. This observation we had made ourselves even before the paper by Brown, Dale and Feldberg was published, and we have dealt fully with the point in a paper which has for some months been awaiting publication in the *Journal of Physiology*. A preliminary account of the observation had, indeed, already been given by one of us (Z. M. B.) in a review published as long ago as October 11, 1936, in *Liége Médical*.[3] The journal in question has probably not a wide currency, and we welcome the note by Morison and Rosenblueth, as showing that they had independently confirmed our observation.

Z. M. BACQ
G. L. BROWN
NATIONAL INSTITUTE FOR MEDICAL
RESEARCH, LONDON

SCIENTIFIC BOOKS

RECENT PHYSICS

The Renaissance of Physics. By KARL K. DARROW, pp. 306, $3.00. The Macmillan Company, 1936.

THE author of this volume is no stranger to the world of physics. Eight or ten years ago a stream of luminous essays poured forth from the Bell Telephone Laboratories under the title of "Some Contemporary Advances in Physics." These immensely helpful papers, directed mainly to his professional colleagues, disclosed not only a remarkable grasp of the various fields of recent physics but also a rare mastery of the art of exposition.

The present volume, however, is the outgrowth of a series of Lowell Lectures, greatly amplified but still addressed to the intelligent reader whether with or without laboratory experience. It is indeed one of those rare messages which contain much for the beginner and much for the expert, reminding one, in this respect, of Maxwell's "Matter and Motion" and Tait's "Recent Advances in Physical Science."

If the merits of a volume are to be appraised upon the matter which is chosen for discussion, upon the worthiness of the treatment and upon the tenacity with which it holds the interest of the reader, Dr. Darrow's "Renaissance of Physics" must take high rank. For the task undertaken is the explanation, in words of one syllable, of the rapid evolution of physics during the last fifty years; but this is to be done by building upon foundations already firmly established; and there is to be no discontinuity with the classical physics. "The continuity of thought," he says, "the partial adequacy of old ideas to new discoveries—these have outrun anything which the physicists of the past could reasonably have foreseen." The entire discussion is based upon the solid ground of mechanics, heat and waves. The spirit of the author is well exemplified at the very outset by the manner in which he wisely detours the definition of physics, with all its metaphysical quagmires, and, in its stead, defines a physicist as "some one who uses his senses for observing; mechanical and thermal instruments for measuring; and mathematics, especially the mathematics developed in the service of physics, for reasoning. I say nothing about a limitation of the subjects of his inquiry; there is none—he is authorized to use his methods and his mathematics on anything whatsoever."

The second and third chapters lead up through Gilbert Faraday, Hittorf, Crookes and Edison to J. J. Thomson and "the release of electrons from matter . . . an event . . . of transcendent importance." Here again I quote a thoroughly pragmatic definition to illustrate the beautiful accuracy with which the author fits his language to his purpose. "May we say," he

[5] Ferber, *Jour. Amer. Dental Assoc.*, 23: 788, 1936.
[1] A. Rosenblueth, D. B. Lindsley and R. S. Morison, *Amer. Jour. Physiol.*, 115: 53, 1936.
[2] G. L. Brown, H. H. Dale and W. Feldberg, *Jour. Physiol.*, 87: 394, 1936.
[3] Z. M. Bacq, *Liége méd.*, No. 41, p. 1173, Oct. 11, 1936.

asks, "that 'vacuum' shall stand for any density of gas, however high or low, provided only that what is left of the gas in the tube is not interfering at all with the phenomena which we happen to be observing?" The discovery of the Edison effect is alluded to as "one of the observations which change the course of history."

A fine illustration of the manner in which a discussion can be made quantitative without the use of mathematical symbols is found in chapter IV, where various matters beside electrolytic conduction and the size of the electronic charge are taken up. One factor which contributes largely to the outstanding clarity of the book is the use of excellent metaphors and similes. Here, for example, is the ferryboat upon which electrons travel; and again a metal described as "a forest in which the motionless trees stand for atoms with positive charges, while the footloose electrons correspond to roving wild beasts." No man, if he reads this while he is awake, can lay the book down without having a clearer conception of what happens in the photoelectric effect and in thermionic emission from incandescent metals.

"The Mystery of Waves and Corpuscles" is the heading of Chapter VIII; and the mystery largely remains —I think the author himself will agree with me—when the end of the chapter is reached. Here, if anywhere, it would appear that some discontinuity between classical and recent physics must be admitted. When the two fundamental equations of Einstein

$$E = h\nu \quad \text{and} \quad p = h/\lambda$$

come up, the author frankly confesses that the problem of "making sense" of these two rules is "a very tough one." "So tough is it," he says, "that physicists have been driven to all manner of singular devices. It is the origin of most, if not all, of the amazing and baffling assertions which have crept into popular literature—sources of grief to those who expect a classic sobriety of statement from the scientist, and of malicious joy to those who like to see unsettlement and incoherence invading an authoritative science."

The paragraph just quoted, coming at the end of a brilliant chapter, easily turns one's mind to the following remark of Professor Max Born in his "Atomic Physics" (p. 120) that "There is naturally no way of deducing the wave-equation by strict logic; the formal steps which lead to it are merely matters of clever guessing."

The structure of the atom is taken up in Chapter IX, which opens with the following thumbnail sketch of this complex microcosm:

> An atom is a constellation of negative electrons organized and held together by the attraction of a positive charge ensconced upon a nucleus which is the center of the constellation and is many times more massive than all the electrons put together.

Here before the end of the chapter is reached Dr. Darrow lays down the solid foundations of spectroscopy and clearly enunciates the basic principles which underlie the work of Aston and Dempster. He also embraces this opportunity to pay his respects to Pythagoras by imagining the delight with which this ancient Greek would have listened to the story of Moseley's discovery that the various elements differ one from another, mainly in a number which is attached to each by definite experimental fact.

The next two chapters are devoted to "the masterpiece of the contemporary group of physicists," *the transmutation of the elements*. Here, in following the work which Lord Rutherford initiated in 1919, the author is at his best and even outdoes his own previous achievements in clear and picturesque exposition. Witness the following account of the production of radio-sodium in the cyclotron of Lawrence and of the evidence for thinking that a neutron lurks in every deuteron:

$$_{1}H^{2} + {}_{11}Na^{23} \longrightarrow {}_{11}Na^{24} + {}_{1}H^{1}$$

upon which he comments, "One may imagine that the neutron is charioted by its attendant proton to the portals of the nucleus through which it slips while its companion is barred out." This penultimate chapter carries the happy title, "Victory over the Elements"; and the volume is fitly brought to a close by one on "The Unity of Nature," in which the remarkable theorem of Einstein, that "Any energy E has a mass E/c^2; any mass m has an energy mc^2," is established in beautifully logical sequence and in carefully chosen words. The reader is here introduced to the crowning achievement of twentieth century physics—the establishment of each of the great laws of conservation of matter and of energy by uniting them into one single valid general principle.

So much for the contents and style of this admirable book, characterized by accurate scholarship, perfect clarity, fine perspective and fascinating diction. If I were an instructor in English composition, I would probably disapprove of the efflorescence of parentheses which meets the eye in every chapter; this on the principle that the introduction of round brackets is, in general, a confession of obscurity in the structure of the sentence. But those of us who have read or listened to Dr. Darrow know how deftly these asides are woven in, how much they add to clarity and how cleverly they protect the reader from wrong impressions.

When one is just arising from a bountifully spread table, nothing could be more ungracious than to complain because some additional course had not been served. So I am not going to ask for an additional

chapter, but merely remark that these eleven chapters whet one's curiosity as to what comment the author would make upon the view of Sir J. J. Thomson ("Recollections and Reflections," pp. 368–9) that "the mass, momentum and energy of a charged sphere are distributed throughout the medium around it and not in the sphere itself."

When the present administration has completed its investigation of the methods of the American Telephone and Telegraph Company it is to be hoped that they will find both reason and space for commending the policy of any corporation which has the wisdom, foresight and ability to maintain a research staff of the caliber of the men now at the Bell Telephone Laboratories and of their late director, to whom the book is so appropriately dedicated.

Henry Crew

NUCLEAR PHYSICS

An Introduction to Nuclear Physics. By N. Feather. x + 213 pp. 21 figs. 3 plates. New York: The Macmillan Company; Cambridge: The University Press. 1936. $3.00.

Radioactivity was discovered in 1896 by Becquerel in connection with studies concerning the nature of fluorescence. Later developments, coming as a result of this discovery, have been of benefit both to the medical profession and to physicists and chemists wishing to gain an insight into the fundamental properties of matter. Alpha-particles, obtained from radioactive elements, were the tools with which Lord Rutherford was able to perform his scattering experiments, the results of which led to the famous nuclear atom (1911). This hypothesis was the foundation stone upon which Bohr was able to build his theory of the hydrogen atom. The tremendous developments brought about in physics, chemistry and astronomy as a consequence of Bohr's theory are now known to every one.

While rapid strides were being made in understanding the outer structure of the atom, steady progress was also being made in our knowledge of the nucleus, albeit this work was somewhat eclipsed by the great volume of papers in the other field. Since the discovery of the positron, the neutron, artificial radioactivity and transmutations by high velocity particles, the amount of work being published on nuclear physics is beginning to rival that produced during the atomic structure "boom" of the 1920's. The author of the present volume has made very notable contributions to the study of nuclear physics.

With experimentation in nuclear physics going forward at such a terrific rate, one would have a certain feeling of futility in attempting to write a book on the subject, since it would be supposed that the book would be out of date before it could possibly be published. It takes rare skill on the part of the author to choose material which will be fundamental and at the same time up to date, and a considerable amount of speed on the part of the publisher to get the book off the press and distributed in a very short length of time. This rare feat has been accomplished in a singularly successful manner by Dr. Feather and the Cambridge University Press.

The book is divided into four parts, the first of which is introductory in character, giving the necessary background for an understanding of the subject. The next three parts treat in turn stable nuclei, unstable nuclei and transformations produced by fast-moving particles and by radiation.

The superbly written introductory chapters give an excellent description of the development of atomic and nuclear physics during the last forty years. At the outset the author describes in detail the types of measurements made in experiments on nuclear physics, showing clearly the relation of the quantities measured to our well-known standards of length and mass. In these introductory chapters all branches of physics having to do with the study of the nucleus are concisely discussed, the essential points being introduced in such a way that the fundamentals are clearly before the reader at all times. After a discussion of the important experiments on radioactivity and scattering of alpha-particles, the results are considered in the light of the classical theory—including also the Bohr theory. The shortcomings of the classical theory in accounting for certain experiments in nuclear physics are pointed out and the wave mechanics is then introduced from an experimental point of view, without recourse to mathematics. The general results of the theory are given and the uranium paradox, resonance capture, and the scattering of identical particles are treated. The closing chapter of Part I, entitled "Elementary Particles: Nuclear Structure," contains an account of the various suppositions made as to the constitution of nuclei, the laws of force between elementary particles, and a particularly enlightening discussion of the nature of the Heisenberg-Majorana exchange force.

Part II deals with the measurement of nuclear masses by means of the mass spectrograph and by optical methods, together with a discussion of the determination of masses by means of the energy balance in disintegration experiments. The chapter on nuclear spins and moments is somewhat inadequate, but gives the main results obtained in this field, together with a table of nuclear spins and moments.

Part III deals with the emission of alpha-particles, of electrons, positive and negative, and of gamma rays. Since other treatises exist in which the subject of the emission of alpha-particles and gamma rays is

treated in great detail, the present section merely states the main experimental facts and brings the material up to date. The chapter on the emission of positive and negative electrons completes the usual discussion of beta-ray spectra by the inclusion of data on the emission of positrons and electrons from light elements made radioactive by bombardment. The foundations and results of Fermi's theory of beta particle disintegration are clearly discussed and the connection between this theory and Sargent's curves is pointed out. The recent experiments concerning the existence (or perhaps non-existence) of the neutrino are described.

The final section of the book—Part IV—deals with transformations produced by high energy particles and light quanta. The effects produced by alpha-particles, neutrons, accelerated particles and quanta are described in turn. The discussion is well ordered and entirely free from the confusion with which one is confronted if one has to go to the original sources for information. The usefulness of these sections is enhanced considerably by the inclusion of a section entitled "collected results" at the end of each chapter. These sections contain in tabular form all the useful information which has been accumulated to date on induced disintegration.

The book contains an unusually complete list of references. In fact, references to papers published in this country as late as July, 1936, and to English papers published after the book was printed are to be found. The theoretical discussions are treated mostly from the physical standpoint without the use of mathematics. The book should be of great interest both to the specialist in nuclear physics and to one who merely wishes to find out what the nuclear physicist is doing.

ALLAN C. G. MITCHELL

NEW YORK UNIVERSITY

SPECIAL ARTICLES

VITAMIN B_1 AND THE GROWTH OF EXCISED TOMATO ROOTS

IN 1922 one of the authors[1] reported a method of cultivating excised root tips under sterile conditions, and found the growth of excised roots of corn (*Zea mays* L.) to be limited in extent in a modified Pfeffer's solution containing dextrose. As a working hypothesis it was assumed that oxygen, the mineral salts of Pfeffer's solution, glucose and water were insufficient for the continued growth of excised corn roots. In the same year Robbins[2] reported the beneficial effects of autolyzed yeast on the growth under sterile conditions of the excised root tips of corn. Various evidences were presented and discussed, indicating that the yeast was effective by furnishing some accessory growth factor or factors originally supplied to the root tip from the grain but fractionated in subculturing the root tips. The same hypothesis was considered in later papers. However, it was not possible at that time definitely to determine in what the effectiveness of the yeast consisted.

White[3] demonstrated potentially unlimited growth for excised root tips of tomato (*Lycopersicon esculentum* L.) in a solution containing mineral salts, cane sugar and yeast.

Since September, 1935, we have cultivated excised tomato root tips in White's solution, thus confirming his original report of the possibility of unlimited growth of the root tips of this plant. We have found that excised tomato root tips which have been subcultured for some time will not grow in White's solution if the mineral salts are omitted, leaving the cane sugar and yeast only. They will not grow if the cane sugar is omitted; nor will they grow if the yeast is omitted and only cane sugar and mineral salts are present.

The effective materials in the dried yeast are not soluble in absolute ethyl alcohol but are soluble in 80 per cent. alcohol. The residue left after extraction with absolute and 80 per cent. ethyl alcohol is ineffective. The beneficial action of the yeast is not eliminated by autoclaving for 12 hours at 120° C. at pH 9.0. Yeast·ash prepared by ashing at low red heat in a muffle furnace will not replace the yeast.[4] However, we have found excised tomato roots to grow in White's solution in which the yeast is replaced by natural crystalline vitamin B_1 Merck or by synthetic vitamin B_1 Merck.[5] The vitamin is effective at great dilution. Growth of root fragments has been secured in 50 cc of White's solution without yeast to which $1 \times 10^{-4}\gamma$ of natural crystalline vitamin B_1 Merck was added. No growth was secured in the same solution lacking both yeast and the vitamin. The vitamin in this solution was present at a concentration of 1 part in 5×10^{11} parts of liquid or $2 \times 10^{-6}\gamma$ per cc, a dilution of the same order as that found by Kögl[6] to be effective for

[1] William J. Robbins, *Bot. Gaz.*, 73: 367–390, 1922.

[2] *Idem.*, *Bot. Gaz.*, 74: 59–79, 1922.

[3] P. R. White, *Plant Physiol.*, 9: 585–599, 1934.

[4] The authors are indebted to F. Kavanaugh for the preparation of the yeast fractions and for other assistance.

[5] The authors express their appreciation of the assistance of R. R. Williams in securing this material and to Merck and Company for the gift of the synthetic vitamin B_1.

[6] Fritz Kögl, and Benno Tönnis, Hoppe-Seyler's *Ztschr. f. physiolog. Chem.*, 242: 43–73, 1936.

crystalline biotin on yeast. We have not yet determined the lower limit of effectiveness, though we have found concentrations up to 1γ per cc to be harmless and little better than the more dilute solutions. The extreme dilution at which the vitamin is effective accounts for our failure to inactivate yeast by long heating under pressure at an alkaline reaction; the vitamin is not completely destroyed under such conditions and sufficient remains to be effective. The insolubility in absolute alcohol of the effective factors in the dried yeast is probably apparent only. That the vitamin and not some contaminant is the effective agent would seem to follow from the dilutions at which the vitamin is used and because the contaminants are probably not the same in the synthetic and natural products, both of which are effective.

The beneficial effects of yeast on the growth of the root tips is not completely accounted for by the vitamin B_1 content of the yeast, since the growth in White's solution containing yeast is better than in the same solution in which the yeast is replaced by vitamin B_1. Part of the beneficial effect of the yeast is due to the ash elements in it, since growth is improved by the addition of yeast ash to White's solution in which the yeast is replaced by vitamin B_1 and the growth in the latter solution is improved also by the addition of supplementary mineral elements. We have not yet determined whether amino acids, hormones or vitamins other than B_1 present in yeast play a significant rôle in the cultivation of excised tomato root tips.

Our results show that excised tomato roots grow if supplied with water, oxygen, mineral salts, carbohydrate and vitamin B_1. These results are similar to those of Schopfer[7] for *Phycomyces Blakesleeanus* which he has found requires vitamin B_1, though this organism apparently requires asparagine also in addition to mineral salts, carbohydrate and the vitamin. It appears that a medium containing mineral salts, carbohydrate and vitamin B_1 is adequate for the unlimited growth of tomato roots. We have grown excised tomato roots successfully for five months in such a medium through four subcultures without evident diminution in growth rate. Such a medium is composed of known constituents and may be regarded as a synthetic medium adequate for the growth of tomato roots.

Whether any substitute for vitamin B_1 can be found remains to be determined. Present evidence indicates that pantothenic acid (a highly purified sample furnished the writers by R. J. Williams) can not be substituted for vitamin B_1. Another aspect of the problem of general interest and significance is the possible occurrence of vitamin B_1 in highly purified sugars. Judging from the response of excised tomato roots, growth factors (probably vitamin B_1) are present in samples of purified maltose and dextrose secured from various companies. Hall, James and Stuart[8] have reported the occurrence of growth stimulants for yeast in white sugar, and Schopfer[7] found a growth factor for *Phycomyces* in maltose.

Our results confirm the working hypotheses originally formulated to explain the beneficial action of yeast on the growth of excised roots in a mineral solution containing sugar and demonstrate that the parasitic relationship of the tomato root to the top involves both carbohydrate and vitamin B_1.

Whether the medium the writers have used is adequate for all types of plant tissue remains to be seen; the results, however, are significant in presenting a synthetic solution apparently adequate for the growth of one type of plant tissue and should be of interest to those engaged in the cultivation of isolated plant embryos and other portions of higher plant tissues.

WILLIAM J. ROBBINS
MARY A. BARTLEY
UNIVERSITY OF MISSOURI

[7] W. H. Schopfer, *Ber. deut. bot. Ges.*, 52: 308–313, 1934.

[8] H. H. Hall, L. H. James and L. S. Stuart, *Jour. Ind. and Eng. Chem.*, 25: 1052–1054, 1933.

THE SIGNIFICANCE OF THE ADRENALS FOR ADAPTATION[1]

IN the course of our studies on the alarm reaction[2,3] we found that the symptoms of adrenal deficiency are almost identical with those observed in non-adrenalectomized animals after exposure to serious damage. Decreased blood pressure; accumulation of water in tissues, with a simultaneous loss of water from the blood; decreased blood sugar; decreased body temperature; muscular weakness; formation of gastric and intestinal ulcers; are the most characteristic features both of adrenalectomy and of the alarm reaction. We have to conclude, therefore, that there is no specific change characteristic of adrenal deficiency, and that the changes observed after the removal of the adrenals are simply due to the response of the organism to general damage—that is to say, they are changes caused by the alarm reaction. We found, furthermore, that alarming stimuli (*i.e.*, stimuli which would elicit an alarm reaction) will cause much more pronounced changes in adrenalectomized animals than these same stimuli would be able to produce in the normal. This

[1] A detailed publication of the experimental data mentioned in this letter will shortly appear in the "Archives Internationales de Pharmacodynamie et de Thérapie."

[2] H. Selye, *Can. Med. Assoc., Jour.*, 34: 706, 1936; *Nature*, 138: 32, 1936; *Brit. Jour. Exper. Pathol.*, 17: 234, 1936; *Endocrinol.*, in press.

[3] H. Selye, C. Harlow and J. B. Collip, *Endokrinol.*, 1936.

in itself suggested that the function of the adrenals is to increase the resistance of the organism to alarming stimuli; furthermore, we observed that a marked enlargement of the adrenals is a constant result of exposure to damaging stimuli, an observation which corroborates the assumption that these glands play an important rôle in the defence of the organism against alarming agents.

It has been claimed that the adrenal is particularly important for the maintenance of normal body temperature, for the prevention of fatigue following exhausting muscular exercise, for the detoxification of various harmful substances and for the maintenance of a constant blood sugar level. Exposure to variable surrounding temperature, excessive muscular exercise, toxic doses of various drugs or agents apt to cause hypoglycemia, act as alarming stimuli. Consequently a decreased resistance to such agents is to be expected if we assume that the function of the adrenals is to prevent the damaging effects of the alarm reaction. But this evidence was not sufficiently conclusive to justify such a theory. We therefore proceeded to experiment with a large number of rats which we adapted to cold, muscular exercise or various drugs. Since damaging agents cease to elicit an alarm reaction after adaptation has occurred, we could expect this experiment to show whether the damage caused by a certain stimulus in an adrenalectomized animal is the result of the stimulus as such or of the alarm reaction which it produces. We found that animals previously adapted to such stimuli as muscular exercise, cold or toxic doses of drugs will tolerate exposure to these same stimuli very well, even after the adrenals have been removed, while exposure to the same stimuli invariably kills not-adapted, adrenalectomized controls, with symptoms characteristic of adrenal insufficiency and of the alarm reaction.

We concluded from these observations that one of the most important functions of the adrenals is to increase the resistance to alarming stimuli. Since most stimuli are "alarming" when the organism is first confronted with them, the adrenals play a very important rôle in the first stage of adaptation to the conditions of the environment. After this first stage, however, the changes necessary for the acquisition of further adaptation take place in the peripheral tissues. In this stage, the stimulus ceases to be "alarming" and therefore the adrenal hormones are no longer required for the process of adaptation.

We assumed that the symptoms of the alarm reaction are mainly due to the liberation from the tissues of some toxic metabolite (possibly histamine or some physiologically similar compound). If this assumption should prove to be correct, one would have to conclude that the function of the adrenals is to detoxify this metabolite. In this event, there would be no contradiction between our interpretation of adrenal deficiency and the intoxication theory as such or possibly even its more modern modification, the histamine intoxication theory (Lucas). The circulatory theory (Swingle and co-workers) and the carbohydrate theory (Britton and Silvette) consider one symptom of the alarm reaction—the circulatory disturbance in the first case, and the hypoglycemia in the second case—to be the basic cause of all the deficiency symptoms. In the light of our findings, these seem to be the result rather than the cause of the deprivation syndrome. The cause of it is the decreased resistance to alarming stimuli. That is why all these deficiency symptoms will appear in adrenalectomized animals at a time when they would otherwise not be evident—that is, immediately following exposure to an alarming stimulus. It seems quite likely that the loss of sodium which is the basic change according to those who believe in the sodium deficiency theory (Loeb, *et al.*) or the increase in potassium (Zwemer) or the deficiency in phosphorylation (Verzar) or the increase in non-protein nitrogen—all of which have been considered to be the primary change—are also symptoms rather than the cause of adrenal insufficiency.

HANS SELYE

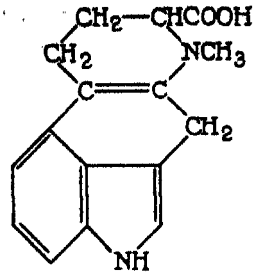
DEPARTMENT OF BIOCHEMISTRY
McGILL UNIVERSITY

THE SYNTHESIS OF SUBSTANCES RELATED TO LYSERGIC ACID

A VERY probable structure for lysergic acid (formula I), the characteristic constituent of the ergot alkaloids, has been derived from the interpretation of, among other things, its characteristic groupings and degradation products.[1] Recently attempts have been made to substantiate this formulation by synthesis. As a first step we have checked the possibility of the production of that portion of this structure composed of the 3-ring system, 3,4-trimethylene indole (formula II). A method to accomplish this was found in the reduction of naphthostyril (the lactam of 8-amino-1-naphthoic acid) with sodium in butyl alcohol. As a by-product a substance normally to be expected was simultaneously formed, *viz.*, 1-hydroxymethyl-8-amino-1,2,3,4-tetrahydronaphthalene. The identities of these substances were shown by their production by a different procedure, namely, reduction of the methyl ester of 8-amino-1,2,3,4-tetrahydro-1-naphthoic acid.

Trimethylene indole exhibits the usual indole reactions but not, however, the characteristic Keller reaction given by the ergot alkaloids (lysergic acid). A nearer approach to the synthesis of lysergic acid

[1] W. A. Jacobs and L. C. Craig, *Jour. Biol. Chem.*, 115: 227, 1936.



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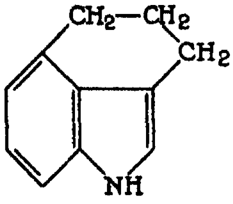

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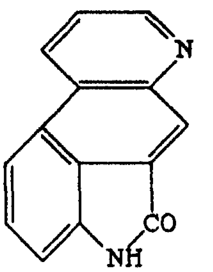
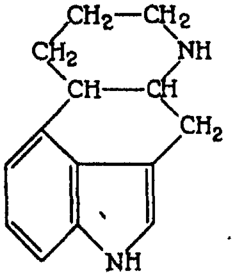


III



IV

itself has more recently been achieved as follows. 3-amino-1-naphthoic acid[2] by the Skraup reaction has given the corresponding β-naphthoquinoline carbonic acid which on nitration yielded a nitro-β-naphthoquinoline carbonic acid. The position occupied by the nitro group became evident after its reduction to the amino group, since lactamization then readily occurred with production of the substance given in formula III. In preliminary experiments, reduction of the latter with sodium and butyl alcohol yielded a mixture containing a substance apparently with the structure given in formula IV, since this mixture gave color reactions closely approaching those which are so characteristic of lysergic acid and its derivatives.

There is now in progress in this laboratory a logical extension of this work to include other substances related to lysergic acid and eventually to lysergic acid itself.

WALTER A. JACOBS
R. GORDON GOULD, JR.
THE ROCKEFELLER INSTITUTE FOR
MEDICAL RESEARCH, NEW YORK

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN AUTOMATIC DEHYDRATING DEVICE

A SIMPLE and satisfactory apparatus whereby histological and cytological tissues may be dehydrated gradually has been devised, thus preventing any shrinkage which may be due to improper upgrading in the alcohol series. By this method tissues for paraffin impregnation may be run up in twelve hours to three days, the length of time depending upon the rate of flow from the siphon.

Apparatus used: A 500 cc flask (A) filled with absolute alcohol is fitted with a one-holed rubber stopper to which is connected a piece of glass tubing about eight or nine inches long, the unattached end having a 15° bevel. The flask is placed upside down and held in place by a clamp on an iron stand (B).

Some distance below the flask, a stender (C) filled with water and containing the tissues is placed. The flask is lowered until the bottom of the bevel of the glass tube extends 1/16 inch below the water level in the stender. Leading from the stender, a piece of capillary tubing, bent at a 50° angle 1½ inches from one end and at the other end drawn to half the original bore, is held in place by a piece of plastic clay moulded over the edges of the stender (D). If the long arm of the siphon is placed in almost a vertical position, the liquid will drain off the tissues at a very rapid rate, but the greater the tendency toward a horizontal position, the more noticeable will be the decrease in the number of drops siphoned per minute. However, the siphon will not work unless the overflow end is placed on a lower level than the suction end, and the suction end must be placed near the bottom of the stender.

As the siphon drains the liquid off the tissues, the level of the mixture of alcohol and water falls below

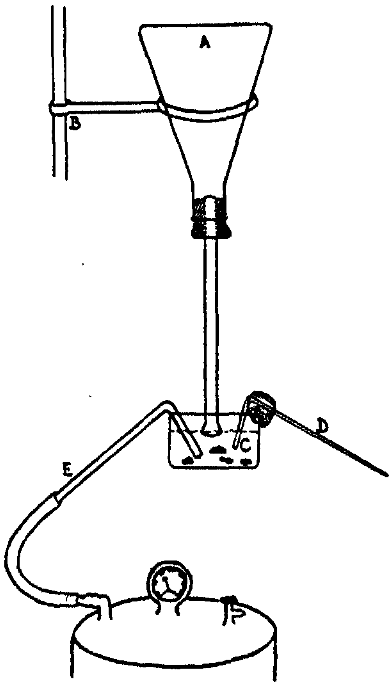


FIG. 1

[2] G. J. Leuck, R. P. Perkins and F. C. Whitmore, *Jour. Am. Chem. Soc.*, 51: 1834, 1929.

the lower edge of the bevel, which causes air to be drawn back into the flask and more alcohol is then introduced into the stender from the flask; when the level of the liquid in the stender reaches the level of the bevel, the flask of alcohol will no longer empty itself.

A provision has been made to insure the proper mixing of the alcohol and water in the stender. An L-shaped piece of glass tubing is connected to a rubber hose which runs to any source of compressed air (E). In the apparatus shown above, an old gas tank, provided with a pressure gauge, inlet and outlet stopcocks, was filled with air by an ordinary automobile air pump, so as to yield a pressure of 20 to 25 pounds. The rubber tube was attached to the outlet and the stopcock was regulated so that there would be 50 to 75 bubbles of air per minute when placed in water. Care must be taken to place the outlet of the L-shaped tube near the bottom of the stender; otherwise the alcohol and water will not mix properly.

If the siphon is regulated at eight drops per minute, the tissue (if placed in 20 cc of water to begin with) will be in approximately 97 per cent. alcohol after twenty-four hours, and is then ready to be transferred into absolute alcohol for 3 to 6 hours, before being placed in the clearing agent.

The apparatus is effective and easy to construct. One should be available on each table of the technique laboratory.

JEAN PENNINGTON
C. P. HICKMAN

DEPAUW UNIVERSITY

THE ISOLATION OF MUSCLE NUCLEI

As a matter of cytological interest and as a means of freeing the nuclei from the cytoplasm for chemical analysis of their constituents, a method has been devised for the isolation of the nuclei of smooth, striated and cardiac muscle. The following procedure yields a permanently stained preparation suitable for cytological study. Cardiac muscle is suggested as an initial preparation.

(1) Smear a slide with Mayer's egg albumen according to the usual method.

(2) Place a drop of 5 per cent. citric acid in the center of the slide.

(3) Place a small piece of fresh muscle in the drop. Gradually the tissue is infiltrated and assumes a translucent state. The citric acid becomes cloudy, due to the released nuclei. Gentle teasing will hasten the reaction. If the preparation is examined microscopically at this time, one will note large numbers of nuclei streaming from the muscle substance.

(4) Remove the muscle from the drop with forceps. The resulting preparation will contain nuclei free of cytoplasm.

(5) Allow the preparation to dry almost completely. The slide is then placed in 95 per cent. ethyl alcohol, which coagulates the albumen, thus holding the nuclei in place.

(6) Rinse in several changes of tap water, followed by distilled water.

(7) Transfer to Mayer's hemalum until the nuclei are stained.

(8) Wash in tap water until blue.

(9) Counterstain in eosin.

(10) Dehydrate, clear and mount.

The technique is comparatively simple. The only possible cause of failure is the washing off of the preparation in step five. Perhaps a repeated attempt may be necessary for determination of the optimum time for drying the slide before placing in the 95 per cent. alcohol.

The resulting preparation shows an abundance of nuclei stained blue on a quite homogeneous eosin-stained background. The latter is presumed to consist of egg albumen and any muscle fraction soluble in the citric acid. Although the technique is applicable to a number of other body tissues, somewhat inferior results are obtained.

GERMAIN CROSSMON

THE UNIVERSITY OF ROCHESTER
SCHOOL OF MEDICINE AND DENTISTRY

BOOKS RECEIVED

BUTLER, LORINE L. Birds Around the Year. Pp. xi + 242. 8 plates. Appleton-Century. $2.00.

Culture Methods for Invertebrate Animals. A Compendium prepared cooperatively by American zoologists under the direction of a committee from Section F of the American Association for the Advancement of Science. PAUL S. GALTSOFF, FRANK E. LUTZ, PAUL S. WELCH and JAMES G. NEEDHAM, Editors. Pp. xxxii + 590. 84 figures. Comstock. $4.00.

DOORLY, ELEANOR. *The Insect Man: Jean Henri Fabre.* Pp. xvii + 180. Illustrated. Appleton-Century. $1.50.

FRANKENBURGER, W. *Katalytische Umsetzungen in Homogenen und Enzymatischen Systemen.* Pp. xi + 444. 22 figures. Akademische Verlagsgesellschaft M. B. H., Leipzig. RM 36.

HERMANN, GRETE, E. MAY and TH. VOGEL. *Die Bedeutung der Modernen Physik für die Theorie der Erkenntnis.* Pp. viii + 210. Verlag von S. Hirzel, Leipzig.

KELLER, FRANKLIN J. and MORRIS S. VITELES. *Vocational Guidance throughout the World.* Pp. xiii + 575. Illustrated. Norton. $4.00.

KOLLER, L. R. *The Physics of Electron Tubes.* Second edition. Pp. xvii + 234. 84 figures. McGraw-Hill. $3.00.

RANEY, M. LLEWELLYN, Editor. *Microphotography for Libraries.* Papers Presented at the Microphotography Symposium at the 1936 Conference of the American Library Association. Pp. xi + 138. The Association, Chicago. $2.50.

THOMSON, SIR J. J. Recollections and Reflections. Pp. viii + 451. Macmillan. $4.00.

WILSON, A. H. *The Theory of Metals.* Pp. viii + 272. 31 figures. Cambridge University Press, Macmillan. $5.00.

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TIMBERLINES AS INDICATORS OF CLIMATIC TRENDS[1]

By Dr. ROBERT F. GRIGGS

THE GEORGE WASHINGTON UNIVERSITY

EVEN though Hutton and Lyell more than a century ago established the principle that the face of the earth has been shaped by forces still in operation, there has remained a great gulf between the geological past and the historical past. Almost ironically, the geologists denominated as "recent" formations of an antiquity far beyond the reach of history. The attempt to bridge the gulf and to connect the past with the present, actually as Lyell did theoretically, is a recent development. The progress toward the construction of a continuous chronology back into the geological past is one of the most significant scientific developments of the last decade. The problem has been attacked from a number of different angles: The excavations of archeologists and their correlation with geological terrains, the records of the annual varves in water-laid deposits collected by DeGeer and in America by Antevs[2]; the interpretation of variant thickness of tree rings in ancient logs by Douglass[2]; the identification of subfossil pollens under the leadership of Erdtmann[3]—each in its own way has helped to carry the chronicle back.

But with all that may be learned by these and other methods, our knowledge of the past must remain very fragmentary. And, what is far more important from my point of view, our appreciation of the long-time climatic trends, which in the end must mould our civilization, is as yet hardly dawning.

[1] Address to the Geological Society of Washington, October 28, 1936.

[2] For a general account see Smithsonian Inst. Publ. No. 3152, pp. 304–312, 1931.

[3] G. Erdtmann, *Archiv. f. Bot.*, 77: 1–173, 1922.

Only recently have we become aware of the fact that in some countries there have been vast changes in climate within the period of civilization, or even within the last thousand years. On the contrary, mankind has generally assumed that such climatic changes as obviously must have occurred in periods of glaciation came on too slowly to have any human importance. More recently, however, our eyes have been opened to the significance of many signs of great climatic changes within historic times. To illustrate my point I need only to cite the extensive evidences of civilization left by former agricultural peoples in parts of Syria now quite too arid for agriculture,[4] or the Old Norse colonies in Greenland whose prosperity was sustained by dairy farming for several hundred years in a region where to-day it is impossible to grow winter feed for cattle. The colonists were buried in ground now perpetually frozen, but their coffins and even the marrow of their bones were permeated by masses of tree roots, which is indubitable evidence of mild temperatures at that time, for roots can not grow into frozen soil.[5]

One of the most significant contributions of geology to biological theory is the revelation of vast migrations of plants and animals over the face of the earth in past times. Knowledge of the movements of the past should surely lead us to suppose that similar migrations are in progress to-day with as great activity as they ever were in past ages. But it is one of the curiosities of scientific thinking that neither botanists nor zoologists have made any serious effort to detect such movements in progress. Indeed, the science of ecology has been built on the contrary assumption that organisms are in stable equilibrium with their environment, which is the same as saying that species have spread as far as is permitted by physical barriers. It ought to be no very difficult matter to put this assumption to the test and to ascertain in the case of any given plant whether its range is fixed or changing; whether it is just holding its own, advancing into new ground, or giving way before adverse factors which are pressing it toward extinction. Once we obtain a considerable body of data we should be able to form reliable judgments of the climatic trends that are factors in any movements brought to light.

The place to study plants or animals in migration is at the limits of their ranges. Just as it is difficult to observe the ebb and flow of the tides in mid-ocean, so it is difficult to discover biotic shifts in the middle of specific areas. But exactly as one can readily observe small changes in tide level on a sloping beach, so can one detect very slow advances or retreats of species at the edges of their ranges where they stop short and drop out.

My interest was first drawn to the problem when I was working in the Sugar Grove region in Ohio more than twenty-five years ago.[6] But my real opportunity to pursue the matter came with the Katmai expeditions of the National Geographic Society, which took me to the arctic timberline in Alaska.

The town of Kodiak stands almost exactly at the edge of the great forest of Sitka spruce which stretches up the Pacific coast from Oregon and Washington. On the mainland the interior forest of Canadian white spruce likewise reaches its terminus within a few miles of the Valley of Ten Thousand Smokes.

These timberlines naturally invited research into the factors which fixed their position. I say fixed their position, for at the beginning I had no idea other than that they must have extended as far as the climate would permit. So I began the study with the belief that further spread of the trees must be prevented by a failure somewhere of their mechanism for dissemination. Was the climate too severe for them to grow a crop of cones? Did such cones as might occur bear viable seed? Was there heavy mortality among seedlings? Were the trees so stunted that their growth could not keep ahead of death from adverse factors? How did their rate of growth compare with that of the same species several hundred miles back from the edge of the forest?

In none of these particulars were the spruces at Kodiak deficient. They bore cones profusely in each of the six seasons that we observed them. The volcanic ash was in places covered with seedlings as thick as they could stand—a growth much denser than could possibly survive. Other seedlings better spaced continued to thrive and grow vigorously. Neither the form of the trees nor their annual increment suggested stunting. There was none of the dead wood characteristic of timberlines generally. The average width of the growth rings measured at Kodiak was close to one tenth of an inch. Occasionally a tree increased more than an inch in a single year. The growth in thickness is not less but actually somewhat greater than in the same species, as measured by the Forest Service in southeastern Alaska.

Nothing that could be observed about the trees at Kodiak, therefore, gave any indication that they had reached their limit and were held in check by climatic factors. On the contrary, it was found that while all the trees at the very edge of the forest were small, they were also young, seldom more than half a century old. Again, there are no dead trees nor fallen logs at the edge of the forest. But three miles back within

[4] Ellsworth Huntington and Stephen S. Visher, "Climatic Changes, Their Nature and Causes." New Haven, Yale University Press, 1922.

[5] W. Hovgaard, *Geog. Rev.*, 15: 605–615, 1925.

[6] R. F. Griggs, *Bull. Torr. Bot. Club*, 41: 25–41, 1914; *Ecology*, 15: 80–96, 1934; *Ecology*, 17: 380–417, 1936.

the forest were many trees three hundred years old or more, while fallen logs abounded, as in normal forests. Everything that could be observed on the ground, therefore, suggested that instead of being held to a stationary line the forest was advancing.

The conclusion that the forest is advancing in Alaska is by no means original with me. The conditions have been noted by many of the observers who have described the region beginning with Petrof in 1884.[7] The explorers sent out by the Alaska division of the Geological Survey report substantially similar conditions throughout western and northern Alaska.[8] The most easterly point at which an advancing timberline has been definitely reported is at Wiseman (Long. 150°, Lat. 67°30′) by Robert Marshall. Historical accounts of the country in early days confirm conclusions drawn from the forest itself. A century ago the people of Kodiak had to go many miles to find wood such as now grows nearby. There are two islands near Kodiak which in the coast pilot of 1875 are called Woody Island and Bare Island. Woody Island still retains its name, but Bare Island is now covered with heavy forest, and its name has been replaced by another more appropriate. There can be no doubt, therefore, that the forest is actively migrating out into the tundra at Kodiak. One further question for a long time undermined confidence in the conclusions reached. Evidence drawn from the trees on the ground can at best go back only a few hundred years. We might be dealing with nothing more than an episodic oscillation of timberline swinging about a mean which after a few centuries of advance would retreat again, leaving things as they were. To assure ourselves in this matter my colleague, Dr. Paul W. Bowman, made a study of the fossil pollens from the bogs at Kodiak.[9] There was no spruce pollen except an occasional grain such as would be blown from a great distance. The present forest is therefore the first that has occupied this country since the beginning of the bogs.

Turning now to climatic correlations, we find a general belief among botanists, not very well supported by evidence, to be sure, but conforming fairly well with many facts, that tree growth is limited by the isotherm of 10° C. (50° F.) for the warmest month. It is interesting to observe that in southwestern Alaska the isotherm stands 250 miles beyond the edge of the forest.

The facts indicate, I think, that there is occurring in Alaska a plant migration of exactly the same character as the paleontologist finds evidence of in past geological ages. Apparently the climate of Alaska has become mild so recently that the trees have not been able to keep up with the change and occupy all the territory suitable for them.

It should be noted that no certain indication is given as to whether the improvement has stopped or is still going on. But the presumption would be that before dying out the change would slow down, giving the trees opportunity to catch up. Study of this migration front at Kodiak yields information which is probably valuable in reaching an understanding of other migrations past and present. It gives a clue, perhaps, to the failure of botanists generally to recognize migrations in progress. We all know that the winged seed of a spruce tree may be carried many miles by the wind, so that the country beyond the forest border must be liberally sown with tree seed every year. It might be expected therefore that the forest would spread with great rapidity, in the same way that pioneer plants come in on ground laid bare by the retreat of a glacier or as foreign weeds spread like wildfire through cultivated ground.

But the advance of one plant association against another is quite different from the invasion of bare ground where the newcomers meet no competition. The country beyond the forest in Alaska is thickly covered with other vegetation, tall grass or vigorous health which chokes intruders. Very few of them succeed in establishing themselves. The abundant seedlings observed at Kodiak were coming up on the new surface provided by the ash from Katmai. Instead of advancing many miles per annum, therefore, the forest creeps into the grassland very slowly. At Kodiak the advance is of the order of one mile per century.

This will seem a very slow migration, yet to a person on the ground the progress of the trees appears rapid—so conspicuous that it has been noticed and commented on by many non-botanical observers. The advance in northwestern Alaska reported by the geologists is much slower, probably not one tenth as fast. This may seem excessively slow, but I suspect that as such migrations go it is rapid. I have no doubt but that with proper technique advances or retreats of vegetation lines as slow as a mile in a hundred thousand years would be readily observable. But it would probably not be possible to assign quantitative rates to slow migrations.

If the testimony of the varves is to be relied on as evidence of the rate of climatic change responsible for the glacial retreat, movements of species on the edges of their ranges slower than changes in Pleistocene climate can be detected. There is little doubt that a comprehensive study of the many species which reach their limits in the vicinity of Washington, for instance, would give us a good picture of current trends in plant

[7] Ivan Petrof, Alaska, U. S. Tenth Census, Pt. 8, p. 75, 1884.

[8] Philip S. Smith and J. B. Mertie, U. S. Geol. Survey Bull. 815, p. 72, 1930.

[9] Paul W. Bowman, *Ecology*, 15: 97–100, 1934.

migration and probably of climatic change also, in this vicinity.

Returning now to the more immediate problem revealed by conditions in Alaska, we must inquire as to the extent of the migration and climatic change indicated. In our southwestern States the flora gives much evidence of having been in a static condition over a long period. There is no time here to go into the details of this evidence. I will merely cite Pearson's[10] careful study on the San Francisco Mountains of Arizona, where his instruments at timberline gave exactly the theoretical temperature limit, showing during the years of observation an isotherm of precisely 50° for July.

In northeastern America, on the other hand, the starvation of the Norse colonies in Greenland, already alluded to, indicates deterioration of climate perhaps compensating the amelioration demonstrated in Alaska. This suggestion is supported by the opinion of Canadian explorers, who think that the forest is retreating in that quarter. But the forest border has never been carefully studied there, and conditions certainly should be looked into.

Meanwhile, the more immediate question seemed to be to find out how far east and south the forest advance might extend. Accordingly, I spent the field season of 1935 studying timberlines in the mountains lying between the apparently static condition of the Southwest and the unstable forest border of Alaska, working north from southern Wyoming to Jasper and back again in the Cascades.

There are in this region many places where young trees are advancing into grassland areas, giving appearances very similar to the migrating forest front at Kodiak. Such a place, which is well known to many of you, is Paradise Park on Mount Rainier. But almost without exception when such places were studied there was clear evidence of an earlier forest in the shape of old stumps or charcoal. Though no evidence of fire was detected in Paradise Park, charred logs abound not many miles away in Indian Henry's Hunting Ground, where new growth is also coming in, as in Paradise Park. Thus it seems likely that all the manifest upward extension of the forest about Mount Rainier is merely in the nature of recovery from fire rather than real advance. Such parks, moreover, lie below the limit of trees. Higher up on Mt. Rainier as elsewhere the last trees are prostrate mats which give evidence of having ascended as high as climate will permit.

A climatic timberline, representing as it does a delicate balance between opposing forces in nature, is modified by very slight disturbances and recovers its original condition very slowly. When a Douglas fir or yellow pine forest in the Rocky Mountains burns, it is replaced by lodgepole pine, and no man knows how many centuries elapse before the original climax forest returns—this at low altitudes. At timberline recovery is much slower. But though on Mount Rainier the original timberline forest was in places, at least, destroyed by fire, fires are in general less frequent near the peaks than at the foot of the mountains.

A more common source of timberline modification is grazing. It is astonishing to one who has not studied the matter to find how little grazing it takes to disturb conditions at timberline. Around Lake O'Hara in the Canadian Rockies, for example, sheep or cattle have never been grazed, as they have on almost all the mountain meadows in our national forests. The only live stock which has been pastured there is a small number of pack horses used by tourists going in and out to the lake. But one familiar with primeval timberlines at once recognizes that the foraging of these animals has upset natural conditions. Wherever undisturbed timberlines were found in the Rocky Mountains, they appeared to be stabilized. No evidence of advance was detected.

In a few places, as around Lake Louise and on Mount Hood, there was, locally, clear evidence that timberline was in retreat. Such isolated withdrawals are presumably due to locally unfavorable conditions. Dr. W. W. Rubey informs me, for example, that the white-bark pines in the southern part of the Wyoming Range have recently died in large numbers. Local irregularities of this sort are to be expected. They serve to emphasize the necessity of an extensive view if conclusions as to climatic change are to be drawn.

The stability of timberlines in the Rocky Mountains, coupled with rapid advance in western Alaska and evidence of increasing cold in northeastern Canada, affords, I think, an important insight into the character of climatic changes in general. In common with most others, I used to suppose that the great climatic changes indicated in geologic times were world-wide in scope. Conditions here in North America make it clear that shifts in climate of sufficient magnitude to become of geological significance are not necessarily even continental in extent, but may occur in much smaller areas. It will be recognized that this greatly simplifies the problem of accounting for such things as ice "ages," since it may involve merely a redistribution of the heat and rain received by the earth rather than variations in the total amount. It is clear, for example, that an interchange of the climate now prevailing in southern Norway with that of Greenland at the same latitude would have a profound effect on the floras of those regions and would, indeed, make the

[10] G. A. Pearson, U. S. Dept. Agric. Tech. Bull. 247, 1931.

name Greenland again appropriate, as it was when the country was originally discovered, permitting again its enthusiastic colonization by people familiar with Norway.

Like the archeologists who unearthed the evidence that the climate in Greenland had changed so radically, the botanist is unable to bring forth the data from meteorology, geology and oceanography which might enable us to understand the change demonstrated. But if we are convinced that we are witnessing just such a climatic change as has characterized the Pleistocene throughout, researchers in these sciences ought to be able to discover the causes at work and thus to find the answer to what is perhaps the greatest riddle of geology.

Meanwhile, there is an immense amount of work to be done in examining plants on the edges of their ranges everywhere. This I expect to push actively myself, and it is my earnest hope that others also may be persuaded to take up the work and push it along until a mass of data and a technique adequate for broad general conclusions may become available.

OBITUARY

RICHARD CRITTENDEN McGREGOR

THE death at Manila, on December 30, 1936, in his sixty-sixth year, of Richard Crittenden McGregor, chief of the division of publications, Department of Agriculture and Commerce, and managing editor of the *Philippine Journal of Science*, brought to a close the career of one of the rapidly dwindling number of early American pioneers in scientific work in the Philippines. Born in Sydney, Australia, on February 24, 1871, he was educated in Stanford University, where he obtained his A.B. in 1898. After five years of varied field experiences in Panama, in Lower California and in the U. S. S. *Pathfinder*, he came to the Philippines in 1901 to join the staff, as ornithologist, of the Bureau of Science, which at that time was just being organized. The enthusiasm he put into the then almost virgin field of Philippine ornithology is attested by the fact that our present coordinated knowledge on over 750 species, in about 300 genera, a good number of them being unknown to science before he had taken a hand, is largely due to his efforts. McGregor's basic work on the features of distribution of bird genera and species in the Philippines has furnished one of the most convincing lines of evidence in the faunistic alliances of the various islands in the Archipelago.

But it is not in birds alone that science in the Philippines is indebted to him. He was an inveterate collector of natural history objects. Many species of insects and other animals, as well as of plants, have been described or recorded from many parts of the Philippines that are difficult of access, on the basis of material brought back by McGregor from his numerous field trips.

Although formally designated managing editor of the *Philippine Journal of Science* in 1919, his editorial connection with that paper had long antedated that year. He was largely responsible for making it a worthy exponent of scientific progress in this part of the world. McGregor had, prior to his death, been waging a two-year losing battle with polyneuritis, which rendered him almost a cripple. But, so devoted was he to the task that, a few weeks before the end, when he must have been suffering intense physical pain, he wrote the undersigned from his sick bed (August 2, 1936): "I do nothing but work on copy and proof, and even so am never out of work. I don't mind working Sundays, but I miss wandering around the fields and forests."

Posterity is prone to give all the honor to the United States army and navy forces for the successful implantation of American sovereignty in the Philippines. In the rapid pacification of the Philippines and the progress the country attained under American direction along educational and material lines, their due share of the credit is quite frequently denied the early American civilian workers—educators and scientists of the type of Richard Crittenden McGregor. Careless of his own well-being, absorbed as he was in the stronger call of scientific pursuits, but meticulous to a fault, even to the extent of going out of his way, where it involved the welfare of his coworkers, contagious in his zeal for work, patient, thoroughly human—his were the attributes that would attain the effective conquest of any people.

LEOPOLDO B. UICHANCO
COLLEGE OF AGRICULTURE,
UNIVERSITY OF THE PHILIPPINES

HARRY NELSON VINALL

HARRY NELSON VINALL, senior agronomist of the Bureau of Plant Industry, U. S. Department of Agriculture, died suddenly on February 22 at his home in Washington, D. C., as the result of a heart attack. He had been connected with the department since 1906, devoting his time to research with forage crops, especially sorghums and grasses. During the last ten years he had been particularly active in pasture research. Born on a farm in Story County, Iowa, the son of George W. and Delina Neal Vinall, he was graduated a bachelor of science from Kansas State Agricultural College in 1903 and a master of science from Cornell

University in 1912. He is survived by his widow, Mary Agnes Austin Vinall, whom he married in 1912. Mr. Vinall was a member of the American Association for the Advancement of Science, the American Society of Agronomy, the American Genetic Association, Botanical Society of Washington, Sigma Xi and Phi Kappa Phi.

P. V. C.

RECENT DEATHS AND MEMORIALS

DR. WILLIAM T. HORNADAY, who retired as the first director of the New York Zoological Park in 1926 after serving for thirty years and who since has devoted himself to the protection of wild life, died on March 6 at the age of eighty-two years.

DR. WILLIAM ALANSON WHITE, for the last thirty-four years superintendent of St. Elizabeth's Hospital at Washington, D. C., and professor of nervous and mental diseases at the George Washington University, died on March 7. He was in his sixty-eighth year.

DR. J. J. DAVIS, who since 1911 has been curator of the University of Wisconsin Herbarium, died on February 26. He was eighty-four years old.

WILLIAM M. BEAMAN, chief of inspection and editing of the topographic branch of the U. S. Geological Survey since 1918, died on March 1.

C. P. BLACKWELL, dean of the School of Agriculture of the Oklahoma Agricultural and Mechanical College and director of the experiment station at Stillwater, formerly professor of agronomy at Clemson College, S. C., died on March 4, at the age of fifty years.

DR. CHESTER ROY GARVEY, assistant professor of psychology at the Carnegie Institute of Technology, died on January 26 at the age of thirty-four years.

Nature reports the death of Professor Max W. C. Weber, formerly professor of zoology and comparative anatomy in the University of Amsterdam, on February 7, aged eighty-four years, and of Dr. Alfred Daniell, author of "Text-book of the Principles of Physics," on January 12, aged eighty-three years.

THE dedication of the Theobald Smith Memorial Laboratory of Albany Medical College, Union University, will take place on March 19, 1937. In the afternoon Dean Thomas Ordway will make an address at the unveiling of a plaque of Theobald Smith. At the evening exercises Dr. Charles R. Stockard, of Cornell University Medical College, will deliver an address on "The Spirit of the Laboratory." The Theobald Smith Memorial Laboratory houses the departments of physiology and pharmacology and of experimental surgery.

THE South Eastern School of the Society of Foresters will erect a memorial to the late Dr. Austin H. Cary in the forest that has been named in his honor at the University of Florida.

SCIENTIFIC EVENTS

THE WILD LIFE FEDERATION

AT the recent meeting in St. Louis of the North American Wild Life Conference a permanent Wild Life Federation was formed. Delegates to the conference voted unanimously to ratify the constitution which was presented at the meeting in Washington last year. The federation as set up at present represents some 3,000,000 persons. It was stated that it had a potential representation of 36,000 groups, with an estimated membership of 30,000,000 citizens.

Jay N. Darling, of Des Moines, who was chief of the Bureau of Biological Survey from March, 1934, to November, 1935, long a leader in the fight to coordinate conservation forces, was elected president by acclamation. The delegates gave him an ovation when his name was proposed by William Tucker, of Texas.

At the afternoon session Mr. Darling recommended a seven-point program to be pressed by the federation, as follows:

1.—Establishment of government responsibility for restoration and conservation of wild life.

2.—Establishment of standing committees of both houses of Congress to further conservation interests.

3.—Adequate funds for the United States Biological Survey and United States Bureau of Fisheries.

4.—Cooperative research between the Federal and State Governments on matters affecting wild life, with the earmarking of funds taken in taxes from sportsmen for conservation—$3,500,000.

5.—Complete federal custodianship of waters.

6.—Federal appropriations for wild life research.

7.—Support of program for continued enforcement of all game laws.

Several resolutions were adopted covering high points of the conservation program.

The first official action taken by the federation was to approve a plan to carry the conservation message into the homes of the nation through the establishment of an annual "Wild Life Restoration Week," which was set tentatively as the week of February 20, 1938. Before that time the federation will initiate an intensive educational campaign.

The following resolutions were adopted by the federation:

Federal aid should be extended to state wild life projects by earmarking funds now received by the United States Treasury from the 10 per cent. excise tax imposed on the sale of sporting arms and ammunition.

The CCC, United States Forest Service and Park Service should conform to sound policies of wild life management.

Any modification of federal law relaxing restrictions on importations of live stock from countries where foot and mouth disease now exist should be vigorously opposed.

The Federal and State Governments should make adequate appropriations for wild life research.

The open season for trapping should be not more than two months in the prime fur season, issuance of special licenses for trappers only and passage of laws to protect fur bearers.

The following vice-presidents, to assist President Jay N. Darling, were elected: David Aylward, secretary of the Massachusetts Fish and Game Association, Peabody, Mass.; William L. Finley, of Portland, Ore., and Dr. Walter B. Jones, of Tuscaloosa, Ala., director of the Alabama Museum of Natural History and state geologist.

REORGANIZATION OF THE COLLEGE OF PHARMACY OF COLUMBIA UNIVERSITY

A JOINT committee, consisting of five members from the faculty of Columbia University and three members from the College of Pharmacy, has made a survey of the school in order to make suggestions in regard to enforcing higher standards of admission, the introduction of academic subjects into the curriculum and in general a closer relationship between the college and the university.

Representing Columbia University on the reorganization committee were: Arthur W. Thomas, professor of chemistry, *chairman;* Charles C. Lieb, Hosack professor of pharmacology; George B. Pegram, professor of physics; Frank H. Bowles, acting director of university admissions, and Frank D. Fackenthal, secretary of the university. Members of the College of Pharmacy were Edward Plaut, chairman of the board of trustees, *chairman;* Dr. Hugo H. Schaefer, associate professor of chemistry, and Dr. Charles W. Ballard, professor of materia medica. The report of the committee has been approved by the president and council of the university.

A greater interchange of students between the College of Pharmacy and the university is expected to result from the reorganization plan, which will go into effect at the opening of the September term. Many of the courses to be introduced will be identical with those now offered at Columbia College, especially in the field of chemistry.

In commenting on the plans for the reorganization Dr. Ballard said: "This is the first attempt in New York State to develop a close contact between a pharmacy school and its university. We anticipate fewer students the coming year as a result of the higher academic entrance requirements that the university will demand, but we need a higher type of pharmacist."

Another committee, consisting of Dean W. F. Rudd, of the School of Pharmacy, Medical College of Virginia; Dr. W. G. Crockett, president of the American Association of Colleges of Pharmacy, and Dr. Ernest Little, of Rutgers University, has been appointed to make a supplementary survey, to aid in the final reorganization plans.

ECLIPSE EXPEDITION TO THE SOUTH SEAS

PROFESSOR S. A. MITCHELL, director of the Leander McCormick Observatory of the University of Virginia, will be the leader of an expedition sponsored by the National Geographic Society and with the cooperation of the U. S. Navy. The total solar eclipse of June 8 will be observed from one of the islands of the Phoenix Group in the South Pacific Ocean. The other members of the scientific party are: Captain J. F. Hellweg, U. S. N., superintendent of the U. S. Naval Observatory, who will have charge of the Navy's participation in the expedition; Dr. Heber D. Curtis, director of the University of Michigan Observatory; Dr. Paul A. McNally, S.J., director of the Georgetown University Observatory; Professor F. K. Richtmyer, Cornell University; Dr. Theodore Dunham, Mt. Wilson Observatory; Harold E. Sawyer, assistant director of the McMath-Hulbert Observatory; John E. Willis, Naval Observatory, together with a photographer from the National Geographic Society and two radio engineers from the National Broadcasting Company.

The members of the expedition will sail from California by passenger steamers on April 27. With the extensive equipment aboard they will leave Honolulu on May 6 for the trip of 1,800 miles on the U. S. S. *Avocet,* a mine sweeper recently converted to a naval tender. Two of the Phoenix Islands, Enderbury and Canton, are available. The former is nearer the center of the shadow path with a duration of 4 mins. 8 secs., but the landing of the equipment may be difficult. If the landing is too difficult, Canton Island, where the duration is 29 secs. less, may be occupied. The 1937 eclipse has a maximum duration of totality of 17 mins. 4 secs., a longer observation than for any eclipse in 1,200 years. Unfortunately the location where the maximum occurs is 1,500 miles from any land.

The expedition will live in tents ashore. In erecting the instruments the astronomers will have the assistance of the officers and men of the naval vessel, which will stand by during the month of preparation. The equipment will be carried in a hundred cases weighing some ten tons.

The program will be a comprehensive one involving the following: (1) Times of contact observed visually and photographically; (2) photographs of the corona with various cameras and focal lengths up to 19 feet, with ordinary plates, with filters and in color (by three different processes); (3) photographs of the flash

spectrum with concave grating spectrographs used both with fixed and jumping films; (4) photographs of the coronal spectrum with various spectrographs, one using a Schmidt lens; (5) measurement of the total light of the corona; (6) measurement of the percentage of polarized light in the corona; (7) shadow bands.

In spite of distance and isolation, the National Broadcasting Company, over a nation-wide hook-up, will broadcast the progress of the expedition towards its destination, will describe the course of the preparations in the weeks ashore and on eclipse day will give very extended accounts of the observations as they are being carried out on June 8.

SCIENCE ON THE RADIO

FOR two hours and fifteen minutes each week, the nation-wide radio networks carry seven programs of science. In the form of dialogues, dramatizations and talks, these sustaining programs are the result of cooperation between two networks and the several scientific or educational organizations. The networks contribute the time and the producing organizations prepare the programs and arrange for their presentation. Each of the talks is carried by a chain of about 30 to 60 stations and each brings forth a considerable amount of listener interest.

In addition to these programs on the networks, there are numerous programs of local stations which are devoted more or less regularly to science. Sometimes other network programs, such as those devoted to agriculture, include scientific material. Many broadcasts are given at the time of scientific meetings and on other special occasions.

A weekly talk on "Science News of the Week" is prepared in continuity form by Science Service and sent to local broadcasting stations, many of them connected with educational institutions, for reading by an announcer. Since this talk is used by about 50 stations, it is in effect a broadcast available to the whole nation.

The world wide short wave station W1XAL at Boston performs another sort of service in acting as a sort of scientific journal of the air. Each day at 4:55 P. M. EST, cosmic data ursigrams and scientific news furnished by Science Service and often astronomical and other news are broadcast on 11.79 megacycles.

The science programs regularly on nation-wide networks are listed below. Times given are Eastern Standard. CBS means Columbia Broadcasting System and NBC means National Broadcasting Company. Local stations carrying these programs can be determined by reference to programs in local newspapers.

TUESDAY AFTERNOON:

3:45 to 4:00 P.M.—*Have You Heard?*—Curious and interesting facts in natural science, presented under the auspices of the Federal Office of Education. NBC Blue Network.

5:00 to 5:30 P.M.—*Your Health.*—Dramatized health broadcasts under auspices of the American Medical Association. NBC Blue Network.

5:15 to 5:30 P.M.—*Science Service Series.*—A leading scientist is interviewed each week by Watson Davis, director of Science Service. CBS Network.

6:00 to 6:15 P.M.—*Science in the News.*—Arranged by the University of Chicago Educational Council. NBC Red Network.

THURSDAY AFTERNOON:

2:00 to 2:15 P.M.—*Academy of Medicine.*—Medical programs, arranged by the New York Academy of Medicine. CBS Network.

SATURDAY AFTERNOON:

5:30 to 5:45 P.M.—*Drama of the Skies.*—Dr. Clyde Fisher, of the Hayden Planetarium, speaking on astronomical subjects. CBS Network.

SUNDAY MORNING:

11:30 to 12:00 A.M.—*The World is Yours.*—Dramatizations based on Smithsonian Institution activities, arranged by cooperation with the Federal Office of Education. NBC Red Network.

WATSON DAVIS

PRESENTATION OF THE WILLIAM H. NICHOLS MEDAL TO DR. WHITMORE

DEAN FRANK C. WHITMORE, of the School of Chemistry and Physics of Pennsylvania State College, president-elect of the American Chemical Society, received on February 26 the William H. Nichols Gold Medal of the New York Section of the society, at a dinner given jointly by the section and the Society of Chemical Industry at the Hotel Pennsylvania.

More than 400 scientific men, representing many different fields of knowledge and investigation, united in honoring Dean Whitmore, who was awarded the medal for studies in "metallo-organic compounds, especially those of mercury, and in the field of aliphatic chemistry, particularly in molecular rearrangements and in the polymerization of olefins."

Dr. Walter S. Landis, vice-president of the American Cyanamid Company and chairman of the Nichols Medal Jury of Award, presented the medal, which was established in 1902 by the late Dr. William H. Nichols, a leader of the chemical industry and a charter member of the American Chemical Society, to "stimulate original research in chemistry." To insure perpetuation of the medal, a gift of securities was made recently to the New York Section by C. W. Nichols, chairman of the board of the Nichols Engineering and Research Corporation and son of William H. Nichols. Members of

the 1937 Medal Jury, in addition to Dr. Landis, were Dr. L. W. Bass, Dr. J. M. Weiss, Professor A. W. Hixson and Professor Victor K. LaMer.

Dean Whitmore, in his address of acceptance, discussed recent research on polymerization and the genesis and interrelation of his chemical investigations. Professor Marston T. Bogert, of Columbia University, past president of the society, spoke on the scientific achievements of the medallist, and Dr. Gerald L. Wendt, director of the American Institute of the City of New York, outlined his personal career. In his address Dr. Whitmore reported that with the aid of a dozen assistants, he has succeeded, after five years of work, in removing most of the "magic and uncertainty" attached to reactions involved in polymerization, and in reducing these complex changes to an orderly basis.

Dr. Whitmore was born in North Attleboro, Mass., on October 1, 1887, and received his early education in Atlantic City, N. J. Later he attended Harvard University, taking the degree of bachelor of arts in 1911, of master of arts in 1912 and of doctor of philosophy in 1914. He was instructor in organic chemistry at Williams College in 1916–17 and at the Rice Institute in 1917–18. From 1918 to 1920 he was assistant professor at the University of Minnesota, when he joined the faculty of Northwestern University with the rank of professor, serving as head of the department of chemistry from 1924 to 1929, leaving to become dean at Pennsylvania State College.

He is consultant and member of the Scientific Advisory Committee of the Chemical Warfare Service, and was formerly chairman of the Division of Chemistry and Chemical Technology of the National Research Council. In 1932 he was vice-president of the American Association for the Advancement of Science and chairman of its chemical section. Beginning with the treasurership of the Southwest Texas Section in 1917, Dean Whitmore has held many offices in the American Chemical Society, of which he has been a director since 1927. He was an officer of the Division of Organic Chemistry for eight years, and is an associate editor of the *Journal* of the society.

SCIENTIFIC NOTES AND NEWS

THE John Scott Awards for 1937 of the City of Philadelphia, $1,000 and a copper medal, were presented on March 5 to Dr. W. D. Coolidge and Dr. Irving Langmuir, director and associate director of the research laboratories in Schenectady of the General Electric Company, and to Dr. Evarts A. Graham, professor of surgery at the Washington University Medical School, St. Louis. The award to Dr. Coolidge was for his application of a new principle in x-ray tubes and that to Dr. Langmuir for development of the electric bulb now in common use. The award to Dr. Graham was for his application of the x-ray to the study and diagnosis of gall bladder conditions. Dr. Ernest T. Trigg, chairman of the Board of City Trusts, made the presentations.

THE seventieth birthday of Dr. Adolf Meyer and the beginning of his twenty-fifth year as director of the Henry Phipps Psychiatric Clinic of the Johns Hopkins University Medical School will be celebrated on April 16 and 17.

HONORARY scrolls in recognition of "outstanding contributions to the human race" have been awarded by the Columbia Graduate School Alumni Association to John Kunkel Small, head curator of the New York Botanical Garden; Jesse Feiring Williams, of Teachers College; Victor Emanuel Levine, professor of biological chemistry at Creighton University, and William Crocker, director of the Boyce Thompson Institute for Plant Research, Yonkers.

A BANQUET was given on March 4 at Northwestern University for members of the faculty who had served for twenty-five years. These included Dr. Robert Blue, Dr. James Carr, Dr. Arthur Curtis, Dr. Alexander Day, Dr. Charles Freeman, Dr. William Holmes, Dr. George Meyer, Dr. Stephen Ranson and Dr. John A. Wolfer, *medicine;* Professor William Bryan and Professor Walter K. Smart, *English;* Professor William Burger and Professor Herbert Philbrick, *engineering;* Professor Elton J. Moulton, *mathematics;* Professor Horace Secrist, *economics;* Dr. William Skillen, *dentistry;* Professor David Himmelblau, *accounting.*

A TESTIMONIAL dinner to Willis H. Carrier was held on February 25 at the Boston Chamber of Commerce, with members of eight societies of air conditioning, heating, refrigerating, mechanical and metallurgical engineers attending. Mr. Carrier made an address on the application of air-conditioning work at the Robinson Deep Mine in the Rand Gold Fields of South Africa.

Museum News calls attention to the following awards made to scientific men in South Africa: K. H. Barnard, assistant director of the South African Museum, Capetown, has been awarded the senior Captain Scott medal by the South African Biological Society in recognition of his researches with South African crustacea and fish. H. M. L. Bolus, curator of the Bolus Herbarium, University of Capetown, has received an honorary degree of doctor of science from the University of Stellenbosch. John Hewitt, director of the Albany Museum, Grahamstown, received the South African medal and

grant from the South African Association for the Advancement of Science at its annual meeting in October at Johannesburg, in recognition of his contributions in zoology and South African prehistory.

THE British Institution of Chemical Engineers has awarded the Osborne Reynolds Medal to Lord Leverhulme, for contributions to the progress of chemical engineering, and the Moulton Medal to Professor D. M. Newitt, of the Imperial College of Science and Technology, for his work on the design of vessels to withstand high internal pressures.

DR. JOHN HENDLEY BARNHART, of the New York Botanical Garden, has been elected president of the Torrey Botanical Club for 1937. He has also become editor for the New York Academy of Sciences.

THE Association of American State Geologists has elected the following officers for the year beginning March 1. *President,* Arthur Bevan, state geologist of Virginia; *Vice-president,* Walter F. Pond, state geologist of Tennessee, and *Secretary,* Raymond C. Moore, state geologist of Kansas. These representatives of the association were also elected: To the National Research Council, Henry B. Kummel, state geologist of New Jersey, on the Division of States Relations, and Henry A. Buehler, state geologist of Missouri, on the Highway Research Board; to the Federal Board of Surveys and Maps, Edward B. Mathews, state geologist of Maryland; Washington, D. C., representative, George H. Ashley, state geologist of Pennsylvania.

DR. HANOR A. WEBB, chairman of the Division of Science and Mathematics of the George Peabody College for Teachers, was elected president of the National Association for Research in Science Teaching for 1937 at the meeting held in connection with the Department of Superintendence of the National Education Association at New Orleans. Dr. S. Ralph Powers, professor of natural sciences, Teachers College, Columbia University, was elected *vice-president;* Professor Ellsworth S. Obourn, head of sciences, John Burroughs School, *secretary;* Professor Fred Anibal, assistant professor of education, Stanford University, and Professor Walter G. Whitman, head of the department of science, State Teachers College, Salem, Mass., *members of the executive committee.* The association celebrated its tenth anniversary at this meeting.

HENRY BALFOUR, curator of the Pitt Rivers Museum, has been elected president of the Royal Geographic Society, London.

DR. SIMON FLEXNER, director-emeritus of the Rockefeller Institute for Medical Research, New York, was elected a trustee of the Johns Hopkins University on February 23.

DR. HUGO H. SCHAEFER, associate professor of chemistry at the Columbia University College of Pharmacy and director of its chemical laboratory, has been appointed dean of the Brooklyn College of Pharmacy of Long Island University. He succeeds Dr. William C. Anderson, whose retirement was recently announced.

DR. F. G. GREGORY has been appointed as from October 1 to the chair of plant physiology, University of London, tenable at the Imperial College—Royal College of Science. Since 1931 he has been assistant director of the research institute of plant physiology at the Imperial College.

PROFESSOR R. H. FOWLER, Plummer professor of applied mathematics in the University of Cambridge since 1932, has been elected a member of the Athenaeum Club for eminence in science.

MRS. AGNES CHASE, senior botanist in the Bureau of Plant Industry of the U. S. Department of Agriculture, has been appointed honorary custodian of the section of grasses in the U. S. National Museum. Mrs. Chase was associated with the late A. S. Hitchcock in building up the collection.

H. E. ANTHONY, of the American Museum of Natural History, has been made chairman of the Committee on the Preservation of Natural Conditions recently formed by the National Research Council.

DR. ADOLPH WEINZIRL, epidemiologist of the Baltimore Department of Health, has been appointed health officer of Portland, Ore. He will succeed Dr. John G. Abele, who will become city epidemiologist.

DR. NORMAN TAYLOR, formerly of the New York Botanical Garden and the Brooklyn Botanic Garden, has been appointed director of the recently established Cinchona Products Institute, New York City. The institute will promote medical and industrial research in the use and application of cinchona products.

DR. JOHN W. SCOTT, head of the department of zoology of the University of Wyoming, has been appointed executive secretary of the State Game and Fish Commission. Dr. Scott will be granted an indefinite leave of absence from the university and will assume his new work at once.

L. C. G. CLARKE, fellow of Trinity Hall, curator of the Museum of Archeology and Ethnology, has been appointed director of the Fitzwilliam Museum at the University of Cambridge and Marlay curator as from October 1, in succession to Sir Sydney Cockerell, who retires at the end of September.

DEAN CORNELIUS BETTEN, of Cornell University, sailed on February 24 for England. He plans to work in the British Museum and expects to be absent for three months.

DR. ALWIN M. PAPPENHEIMER, professor of pathol-

ogy of the College of Physicians and Surgeons, Columbia University, and Dr. Frederic M. Hanes, of the School of Medicine of Duke University, have made a stay of several weeks at the School of Tropical Medicine at San Juan, Puerto Rico.

DR. HERMENEGILDO ARRUGA, director of the clinic of ophthalmology at Barcelona, Spain, who has been an exile from his native land since early in the Spanish civil war, is making a lecture tour through the United States, South America and Europe. He plans to return to Spain after the war.

DR. WALTHER KUBIENA, of the Agricultural Institute, Vienna, will be guest professor of soils at the Iowa State College from April 1 to September 30.

DR. THORVALD MADSEN, director of the State Serum Institute of Denmark, who will deliver the Abraham Flexner Lectures at the School of Medicine of Vanderbilt University, will be in residence during the months of March and April. The dates and titles of the individual lectures are: March 10, "Control of Venereal Diseases in Denmark"; March 15, "Mechanism of Bacterial Infection"; March 19, "Epidemiology of Tuberculosis"; March 24, "The Influence of Seasons on Infections," and March 29, "Whooping Cough."

OWING to the flood emergency, it was necessary for Surgeon General Thomas Parran to postpone the Gehrmann Lectures scheduled at the College of Medicine of the University of Illinois, from January 25, 26 and 27 to March 22, 23 and 24. The subjects of the lectures are: "Health as a Factor in Social Security"; "Industrial Hygiene" and "Syphilis."

DR. I. S. BOWEN, professor of physics in the California Institute of Technology, gave on February 17 an illustrated lecture on "Bright-Line Astronomical Spectra" before the University of California at Los Angeles Chapter of the Society of the Sigma Xi.

DR. HERBERT S. GASSER, director of the Rockefeller Institute for Medical Research, will deliver the sixth Harvey Society lecture of the current series at the New York Academy of Medicine on March 18. Dr. Gasser will speak on "The Control of Excitation in the Nervous System."

THE Royal College of Surgeons, England, has appointed Sir Charles Gordon-Watson Bradshaw lecturer for 1937 and Sir Charles Sherrington Thomas, Vicary lecturer.

THE seventh annual meeting of the American Association of Physical Anthropologists will be held on April 9 and 10 at the Faculty Club of Harvard University.

THE date at which the spring meeting of the Midwestern Psychological Association will be held has been changed from April 23 and 24 to May 7 and 8.

THE thirty-second annual meeting of the Southern Society for Philosophy and Psychology will be held at Columbia, S. C., on Friday and Saturday, March 26 and 27, 1937, under the presidency of Lyle H. Lanier. The University of South Carolina is the host institution. Separate sections for contributed papers in philosophy and psychology have been arranged for the Friday morning and afternoon sessions; the Saturday morning meeting will be devoted to papers of general interest from both fields. The annual banquet and presidential address are scheduled for Friday evening at the Hotel Columbia. The annual business meeting will follow the Saturday morning session.

FORMATION of a Cancer Council, to bring together the fields of cancer education, therapy and research and to serve as a liaison agent between the outstanding authorities in cancer and the lay public through the medium of the press and radio, has been announced by Dr. Clarence C. Little, managing director of the American Society for the Control of Cancer. Members of the council include Dr. Frank Adair, of Memorial Hospital, appointed by the regents of the American College of Surgeons; Dr. Karl Kornblum, appointed by the president of the American Roentgen Ray Society; Dr. Little and Dr. James B. Murphy, of the Rockefeller Institute for Medical Research, appointed by the council of the American Society for Cancer Research; Dr. James Ewing, of Memorial Hospital, and Dr. Burton T. Simpson, State Institute for the Study of Malignant Diseases, Buffalo, appointed by the directors of the American Society for the Control of Cancer. The first meeting of the council was held on March 5.

DR. WILLIAM J. ROBBINS, dean of the Graduate School at the University of Missouri, and president of the Missouri Academy of Science, has appointed a standing Committee of the Academy on Conservation, with the following membership: H. C. Beckman, U. S. Geological Survey, Rolla; Dr. H. A. Buehler, state geologist and director, Missouri Bureau of Geology and Mines, Rolla; Dr. H. H. Krusekopf, professor of soils, University of Missouri; Dr. G. T. Moore, director, Missouri Botanical Garden, St. Louis; A. E. Shirling, professor of science, Kansas City Teachers College; E. Sidney Stephens, president, Restoration and Conservation Federation of Missouri, Columbia; Dr. R. H. Westveld, assistant professor of forestry, University of Missouri, and Dr. Rudolf Bennitt (chairman), associate professor of zoology, University of Missouri. The purposes of the committee are: (1) to keep the membership of the academy informed of current activities in the many fields related to conservation of natural resources; (2) to direct the influence of the academy in support of conservational moves which are for the public good, and (3) to assist in placing the scientific resources of this state-wide organization at

the disposal of agencies working toward conservation of the natural resources of Missouri.

A SUIT for recovery of $215,730, allegedly lost by the American Society of Mechanical Engineers in publishing *The Engineering Index,* was brought up in Supreme Court when the plaintiffs moved on February 16 for appointment of a temporary receiver for The Engineering Index, Inc., a separate corporation which has published the index since 1934. The plaintiffs are two members of the society, Clifford J. Stoddard and John Parker, suing on behalf of themselves and other members. The complaint alleges that in 1927 the society advanced money for the *Index* and for a service known as the Engineering Card Index Service, but that eventually the Engineering Index, Inc., was organized as a non-profit-making corporation to publish the magazine, the society receiving a small percentage of the income. The suit seeks to invalidate this agreement and wants an accounting of the corporation. A similar suit, brought in 1935, was dismissed after an official referee found that "no property or funds of the American Society of Mechanical Engineers has been misappropriated or diverted to any other purpose than for which the society was incorporated."

THE *Manchester Guardian* prints in its issue of February 7 the following: "The *Berliner Tageblatt* reports a lecture given by Geheimrat (Privy Councillor) Professor Dr. Stark, president of the National Physical and Technical Institution (Physikalisch-Technische Reichsanstalt), on 'Dogmatism and Experience in Atomic Research.' Professor Dr. Stark, according to this report, rejected the theory of the form of the atom the moment it was put forward by Lord Rutherford and Niels Bohr—less on technical (sachlichen) grounds than from fundamental objections to their acceptance of views and dogmas of Jewish physicists. He now wished not only to criticize but to bring forward something better as an alternative. He described his new model of the atom with the aid of a short film. Its main feature is that the electron has not the form of a sphere, assigned to it by the Jewish physicist Abraham, but that of a vortex-ring (Wirbelring). Jewish influence, said Professor Dr. Stark, had gone so far that even non-Jewish scientists like Planck, Bohr, Von Laue, Schrödinger and Heisenberg had become partisans of the false doctrine (Irrlehre), and no young lecturer who gave a thought to his career dared to oppose the dominant theory. Some particularly pushing physicists married Jewish women in order to advance their careers. Now that these monstrous circumstances had been discovered, German and authentic (arteigene) physics would forge ahead. 'Privy Councillor Stark's lecture is to serve,' the report concludes, 'as a new thrust to eliminate from German physics the effects of the Jewish mind.' Unfortunately, Stark said in conclusion, in the two decades no important discovery had been made by physicists of the German alignment."

DISCUSSION

SURVIVAL OF MARMOTS AFTER NEPHRECTOMY AND ADRENALECTOMY[1]

IN studying a series of nephrectomized marmots (*Arctomys monax*) during the early part of 1936, it appeared very strange that the first animals used did not seem to suffer any ill effects from the operation. Both kidneys had been completely removed at one sitting. For two, three and (in some cases) four weeks they ate and drank freely and appeared in good health, fighting vigorously with their cage-mates occasionally like normal animals. This is strikingly different from observations made on other mammals: rats, guinea-pigs, cats and dogs quickly show severe effects and survive only a few days after bilateral renal excision. All the marmots which were nephrectomized eventually succumbed, however, with the usual symptoms observed in other animal forms. In many observed cases, food was eaten within a few hours of death.

[1] Grateful acknowledgment is made of aid received from the Rockefeller Foundation.

Recalling earlier observations on adrenalectomized marmots which survive for months—until spring time—when operated on during the winter, it was thought possible that seasonal variations in survival after nephrectomy might also be shown by this species. Several animals were nephrectomized, therefore, throughout the summer period—or the warmer half of the year, from April to September, in this latitude. In all these cases the post-operative life-span was very short and approximated that found in the usual laboratory types.

In the winter-nephrectomized group (October to March), four marmots survived 28 to 35 days and two others 21 days each; the average survival period in seven cases was 20 days. In 15 summer-operated animals the life-span averaged, in contrast, only 6 days. The latter group showed considerable reductions in serum sodium and chloride, and more marked rises in blood urea than the winter-operated series. Very high blood urea values, running sometimes over one per cent., were observed.

Observations on adrenalectomized marmots are in some respects similar to the above. Prolonged survivals (average 70 days in 12 cases) occur when the adrenal glands are removed in the months from October to March, and very short survivals (average 5 days in 19 cases) are observed in summer.[2] All animals which are adrenalectomized in winter survive until spring, however, when they die with the usual symptoms of insufficiency. Early winter-operated individuals thus show much longer survival times than others. Five marmots adrenalectomized in November and December, for example, showed survivals which averaged 98 days, while 5 operated on in February and March averaged only 44 days. No comparable winter-month variations in survival have been observed after nephrectomy. There is apparently a definite survival limit of about 4 weeks for winter-nephrectomized marmots, while that for adrenalectomized animals may vary from 5 to 20 weeks according to the time of operation.

It is emphasized that the marmot does not hibernate under ordinary laboratory conditions which are kept fairly constant throughout the year. Body temperature, feeding habits and general activity are normally maintained in winter as in summer, and the body weight is frequently increased. Winter-nephrectomized (or adrenalectomized) marmots are indistinguishable from normal unoperated animals until within a few hours of death. The remarkably long survivals recorded above are probably not referable, therefore, to any reduction in metabolic activities. The dispensability of renal and adrenal functions for very prolonged periods in the marmot is well demonstrated.

S. W. Britton
H. Silvette
University of Virginia

THE BLACK WIDOW SPIDER IN VIRGINIA

Recently, several articles on the distribution of the black widow spider, *Latrodectus mactans*, have appeared in Science. In Lowrie's contribution[1] the statement is made that there now are " . . . only eight states (Minnesota, Iowa, Virginia, Delaware, New Jersey, Connecticut, Rhode Island, Vermont) in which the spider has not been officially recorded." If by "officially recorded," publication in a scientific periodical is meant, this statement is at variance with one in an article by D'Amour, Becker and Van Riper,[2] who combine the distribution records of Burt[3] and Bogen[4]

[2] S. W. Britton, *Amer. Jour. Physiol.*, 99: 9, 1931.
[1] Donald C. Lowrie, Science, 84: 2185, 437, November 13, 1936.
[2] F. E. D'Amour, F. E. Becker and W. Van Riper, *Quart. Rev. Biol.*, 11: 2, 123, June, 1936.
[3] C. E. Burt, *Jour. Kans. Ent. Soc.*, 8: 4, 117, 1935 (cited by Lowrie).
[4] Emil Bogen, *Ann. Internal Medicine*, 6: 375, 1932.

and remark that this " . . . leaves only the following states from which the black widow has not been reported: Oregon, Minnesota, Iowa, Missouri, Wisconsin, Illinois and Vermont." If Oregon, Wisconsin and Illinois, states in which *Latrodectus* has been reported recently,[5] are subtracted from this second list, then only Minnesota, Iowa, Missouri and Vermont are left. When comparison is made with Lowrie's list, they agree on just three states, in which the spider is unreported officially, *viz.*, Minnesota, Iowa and Vermont. By implication, the Lowrie list places the black widow in Missouri while, similarly, the D'Amour article places it in Virginia, Delaware, New Jersey, Connecticut and Rhode Island.

With respect to Virginia, it was rather surprising to find it said that there was no official record from this state, since the black widow is common to abundant in most of the state. There have been several articles on the effect of its bite in the *Virginia Medical Monthly* and the *Proceedings* of the Virginia Academy of Science for 1934–1935 lists a paper on *Latrodectus* read by Elizabeth Burger, then a graduate student in the Department of Biology, College of William and Mary. The synopsis of this paper includes "the incidence of arachnidism in Virginia." In her unpublished master's thesis, on file in the William and Mary library, Miss Burger tabulates 118 cases of Virginians who suffered the serious bite of this spider, the result being fatal in one instance, that of a two-year-old boy in Charlottesville. These data, gathered from a questionnaire sent to hospitals and physicians throughout the state, can not be considered as complete, and also occasional errors in diagnosis are possible, so that the real incidence might be somewhat higher. We are privileged to quote as follows:

> The majority of these cases were in Tidewater Virginia especially around Norfolk and Richmond, and on the Eastern Shore. Fifteen cases from Bristol show that the range of the black widow extends into the mountains in this state.
>
> A large proportion of these cases occurred since 1930. Most of the cases happened in the spring, summer or fall, during the natural breeding season of the spider. . . . The spiders were located in privies in 25 instances, in a garden four times, in bed in three cases, on the ground in three instances, and once each in a stump, baseball glove, bathing suit, tobacco sticks and on a porch. Most of the patients had seen the spider, which they described as "black like a shoe-button with a red spot."

In the vicinity of Williamsburg, specimens can be secured at any time merely by investigating such sites as under stones or bits of wood, along brick walls or

[5] H. M. Field, Science, 83: 2147, 186, February 21, 1936, and L. H. Townsend, Science, 84: 2183, 392, October 30, 1936 (both cited by Lowrie).

foundations at the ground level and on or under vegetation where the air is damp. One spring day, Miss Burger and the writer took 50 individuals of varying stages from the stones of a rock-banded curbing 35 × 2 feet in area. Six months later, the identical site yielded five mature females, one mature male and two immature females. A pile of scattered fenceposts left lying in a field in April had from one to six mature females under each post in October.

In the fall of 1935, an undergraduate in one of the writer's classes was bitten on the hand upon retrieving a tennis ball. Apparently in the very short interval of time the ball lay in the grass outside of the court, a female black widow clung to it and then inflicted the bite as it was picked up. This student's symptoms were typical: The sensation of a pin prick, pain increasing in intensity and localizing in the lower torso, a marked rigidity of the abdominal muscles and prostration. In spite of opiates and other measures, pain, so intense that a wooden gag was necessary, was experienced for about two days. Apparently this case is the first time a student has been bitten while in residence, though the spiders are seen on nearly every collecting trip. In the Elementary Biology Laboratory, one or more *Latrodectus* cultures are kept going most of the year and all students in field courses are warned to respect this dangerous arachnid.

From his personal experience, the writer has concluded that (1) the black widow is abundant in Tidewater Virginia, (2) it is unlikely to inflict its poisonous bite unless handled, and far from invariably then, and (3) its bite is so serious, especially to children, that reasonable caution should be observed when poking into situations where it is likely to be.

It may be relevant to conclude this account with a true and rather amusing anecdote. Some Williamsburg children, sons and daughters of professors as well as colored children, are in the habit of collecting insects and spiders and selling them to biology students for one cent each. One little colored boy discovered purveying black widows at this price was told of the dangerous character of such merchandise. A few days later he was found still selling black widows—but his price had jumped to a nickel each.

RAYMOND L. TAYLOR

DEPARTMENT OF BIOLOGY
COLLEGE OF WILLIAM AND MARY

THE ADSORPTION-ABSORPTION AND TRANSLOCATION OF DERRIS CONSTITUENTS IN BEAN PLANTS

OBSERVATIONS in field work in which derris and cube were used as insecticides showed possibility of the constituents of these roots being adsorbed-absorbed and translocated to new growth of the treated plants.

Two varieties of beans (Pinto and Burpee Stringless Green-pod), grown in pots under greenhouse conditions, were treated before the first trifoliate leaves appeared with suspensions of derris in water, containing 0.025, 0.05 and 0.25 per cent. rotenone. Some of the plants were treated by spraying the entire plant with a compressed-air hand sprayer, some by painting only the first pair of true leaves and some by painting only the stems.

As soon after treatment as the first trifoliate leaves had attained a fair size or about the time the second trifoliate leaves were opening, the first trifoliate leaves were removed from the plants and used for tests. Larvae of the Mexican bean beetle (*Epilachna varivestis* Muls.), confined in open glass cells, were allowed to feed on these leaves and the leaf areas consumed were measured. There was very low mortality among the larvae feeding on the new growth from either the treated or the untreated plants. There was, however, a definite reduction in feeding area of new growth on treated plants over that on untreated plants. This reduction in feeding area was observed on the first, second and third trifoliate leaves.

Chloroform extracts were prepared from the same plants as those used for the feeding tests. These extracts were prepared for biological and chemical tests by evaporating to dryness and removing the residue with acetone. An aliquot of the acetone solutions was tested against goldfish (*Carassius auratus*) in water suspension, and 100 per cent. mortality was observed in every case. No mortality was observed in extracts prepared from untreated plants. Where sufficient leaf material was available, an aliquot was used for the colorimetric analysis.

The data accumulated thus far indicate that derris constituents are being adsorbed-absorbed and translocated to new growth of bean plants treated with a suspension of derris powder in water.

A more detailed paper will be presented elsewhere.

ROBERT A. FULTON
HORATIO C. MASON

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, U. S. DEPARTMENT OF AGRICULTURE

THE SIXTH EDITION OF THE BIOGRAPHICAL DIRECTORY OF AMERICAN MEN OF SCIENCE

A NEW edition of "American Men of Science" is now in preparation. It should be ready in about a year, the present plan being to issue the work once in five years. The fifth edition was published in March, 1933; the dates of publication of the earlier editions were 1906, 1910, 1921 and 1927, one edition having been omitted owing to war conditions. The number of

entries in each successive edition has been about 4,000, 5,500, 9,500, 13,500 and 22,000.

This geometrical increase in the number of American workers in science is most promising for the future of our civilization; but it makes difficult the preparation of a biographical directory containing all the names. Those listed in the directory have probably done more for the welfare of the American people than all the business men of New York and all the political leaders in Washington. But by the nature of things only a few of them can be distinguished.

For a long series of years I compiled and printed in SCIENCE a list of all doctorates in science given by American universities with the subjects of the theses. In 1906 when the first edition of "American Men of Science" was published there were 139; now there are nearly 2,000. The increase in college graduates is still greater; in high-school graduates it is truly remarkable.

It is a problem of interest, which a work such as "American Men of Science" may help to solve, whether scientific men as a group are now on the average less able or do less important work than formerly. They are less distinguished; there may be as many leaders in a savage tribe as in a great nation. The saying "we can not see the forest for the trees" may be reversed to "we can not see the trees for the forest." We should expect to find more able men in a group of 2,000 than in a group of 139, but it may be that the selection is now less severe. We certainly seem not to have as many great men of science as in 1906.

For the new edition of "American Men of Science" we have on cards more than 12,000 new names supposed to have the qualifications used in previous editions. These are the possession of a doctor's degree or similar preparation, the publication of research work contributing to the advancement of science, and the holding of a position that promises a scientific career. It is difficult to select from those having these qualifications the ones who may be expected to contribute most to the advancement of science; yet it is now or will soon become impossible to include in one volume biographical sketches of all those in America who are engaged in scientific work. Under these conditions the editors would like to receive advice from those included in the directory concerning the advisability of several alternatives, namely: (1) Publish the book in two volumes; (2) decrease the length of the entries; (3) give only the names, addresses and positions of those whose sketches have not been changed significantly since the preceding edition was published and (4) limit the entries to about 25,000 of those whose work is supposed to be of most value.

In spite of the circumstance that the directory is as large as it should be, it is the object of this communication to ask those who read it to send to the editors the names, addresses and qualifications of scientific men and women whose names do not appear in the fifth edition and who should now be included. Our lists are nearly complete for those who have received higher degrees since the last edition was published, for those who hold positions in some seven hundred colleges and universities, for those who have contributed to leading scientific journals and for members of scientific societies with research qualifications. But there are other groups not so complete, such as physicians, engineers and others engaged in the professions who have contributed to the advancement of science; teachers in normal colleges, junior colleges and high schools; federal, state and municipal employees; workers in industrial and private laboratories, amateurs and others.

It is further urged that those who have not returned the requests for the needed information do so at once and that those who have received the entries from the fifth edition return them as soon as is convenient with the needed corrections and additions. Proofs will be sent when the sketches have been put in type. It is most desirable that entries and proofs be returned promptly, for otherwise the sketches can not be included in the book, except in special cases when the data can be verified from other sources.

The omission of names that should be included not only detracts from the value of the book, but may be serious for those concerned, for the directory is largely used in connection with appointments, awards, the acceptance for publication of manuscripts and the like. A university executive told me recently that he used the book more frequently than any other and had supplied an additional copy to each of his two secretaries. An executive responsible for recommending the award of large sums in grants has told me that when he leaves home he always takes a copy with him.

The Biographical Directory of American Men of Science is not intended to be only an address book, though it is hoped that as such it is useful. The editor was originally interested in collecting the material for a scientific study of scientific men. Perhaps no advance in our knowledge of the material world can be of such great value as knowledge concerning the natural qualities and environmental conditions favorable to scientific research. If we find the men and give them the opportunity the rest will follow. A second primary object of the work is to make men of science acquainted with one another and with one another's work. As the editor remarked in the preface to the first edition:

There scarcely exists among scientific men the recognition of common interest and the spirit of cooperation which would help to give science the place it should have in the community. It is fully as important for the nation

as for men of science that scientific work should be adequately recognized and supported. We are consequently in the fortunate position of knowing that whatever we do to promote our own interests is at the same time a service to the community and to the world.

The editorial work and difficulties in the preparation of the book are great; the costs of preparation and publication are large. The editors ask those engaged in scientific work to continue the cooperation that they have given in connection with the earlier editions over a period of thirty-five years.

J. McKeen Cattell

Grand Central Terminal,
New York, N. Y.

SCIENTIFIC BOOKS

GEORG WILHELM STELLER

Georg Wilhelm Steller, the Pioneer of Alaskan Natural History. By Leonhard Stejneger, Cambridge, Mass. Harvard University Press, 1936. Pages i to xxiv, and 1 to 623. Frontispiece in color of Catesby's and Steller's Blue Jays; headpiece, the Free Imperial City of Windsheim; and plates 1 to 29. Price, $6.00.

The cross marking Steller's grave and the grave itself have long since washed away; but the young and enthusiastic German naturalist, for twelve years in the employ of the Imperial Academy of Sciences of Russia, has a much greater monument in the biography just published by Stejneger. There is no one so competent to write such a book. As he says in his introduction, the subject of this biography was thrust upon him and was not picked out by choice. Its inception dates back to the days when Professor Spencer F. Baird, secretary of the Smithsonian Institution and director of the National Museum, commissioned the author to go to Bering Island to investigate rumors about the Steller sea-cow, which the hero had discovered on Bering's ill-fated expedition to Alaska. At that time Stejneger spent two summers and one winter (1882–1883) on the Komandorski Islands and Kamtchatka, the winter being passed on Bering Island where the remnants of Bering's crew, including Steller, wintered in 1741–42. Since then Stejneger has visited Bering Island four times, but for much shorter stays. It is no wonder that he became interested in the life of Steller.

Stejneger was more fortunate than Steller; for, though he never saw a live sea-cow, he brought back skeletons, while Steller, for lack of room on the rebuilt *St. Peter,* was permitted no space for carrying to Kamtchatka such a large animal.

During his visit Stejneger made a detailed map of the island, every part of which had been traversed by Steller or the other survivors. This map was used as the topographical basis for the work of the Russian Geological Survey.

There is practically nothing in Steller's life that Stejneger has omitted. Beginning with his family history, his birth on March 10, 1709, Plate 1 is a photostatic copy of the page of the St. Kilian Church register, Windsheim, showing the record of Georg Wilhelm Stöhler's baptism. When Stöhler entered the Russian service, he found no satisfactory equivalents of the letters of his name and so changed it to Steller. In 1927 the author visited Steller's birthplace, and in 1930 went to Halle to look into his university background. He also searched libraries and obtained many photostatic prints of manuscript records regarding Steller's life. Steller had a gifted mind. He was a theologian, physician and, most of all, a naturalist. He was a true "medical truant." Only three times in the book does the reviewer recall references to Steller as a physician: first when he early entered the Russian Army service, later and foremost during the outbreak of scurvy aboard Bering's vessel, the *St. Peter*, on the second Kamtchatka Expedition, and finally when he was critically ill and refused to take medical advice, saying that he was a medical man capable of looking after others and also himself. The outbreak of scurvy is excellently described. It is interesting that two naval surgeons of the second ill-fated Kamtchatka Expedition, both Germans, Johan Theodor Lau and Heinrich Schäfer, attended Steller in his last illness (1746) at Tyumen, Siberia, although they had not been assigned to the *St. Peter*.

One is struck with the absence of a portrait of Steller, until on page 157 he reads: "Unfortunately no description of Steller's physical attributes has been handed down to us, much less any portrait." His mental characteristics are better known, namely, that he was high-strung, temperamental and indefatigable. His industry and innate optimism are well brought out, for, when shipwrecked on an unknown island (Bering), he wrote the manuscript of "De Bestiis Marinis" when other men would have bemoaned their fate.

Forty-four pages at the end are designated as appendices:

A. A description of the pictures of the sea-cow. [Exterminated in 1854, if not earlier.]
B. Steller as an ichthyologist.
C. Steller as a botanist.
D. Steller's hitherto unpublished letter [to Johann Georg

Gmelin] dated Jan. 14, 1740. [A report of his activities.]

E. Steller's Catalogus Plantarum intra sex horas in parti Americae septentrionalis juxta promontorium Eliae observatarum anno 1741 die Iulii sub gradu latitudinis 59. This is the first list of Alaskan plants, about 150, and shows what an indefatigable collector Steller was.

The frontispiece is a copy of Catesby's blue jay, *Cyanocitta cristata,* of the eastern United States as contrasted with the western blue jay, *Cyanocitta stelleri.* It was the presence of this blue jay that made Steller sure North America had been reached; and this is an illustration of the remarkable memory Steller had, as he had once seen a copy of Catesby's work in St. Petersburg many years previously, before he started on his extensive travels.

Stejneger's narrative of the voyage of the *St. Peter* under Commander Vitus Bering[1] from Kamtchatka to Kayak Island, Alaska, until it was shipwrecked at Bering Island, then the making of the new but smaller *St. Peter* and its voyage to Kamtchatka is as interesting reading as Conrad.

The book is more than a biography of Steller, because it gives an account of the history, customs and manners of Russia in Steller's time, two hundred years ago, also much about the lives of his associates. It is well illustrated, but one regrets that it does not contain more plates. The author has left no stone unturned in acquiring facts about Steller's life, either by travel or by correspondence. It is concluded with a bibliography of two hundred and fifty-one titles, many of them in the Russian language. Steller's share in it is seventeen titles written in German and Latin, all the seventeen, except one, published posthumously. The index is complete both as to subject-matter and scientific names. The volume is a model of book-making, well bound and printed on an excellent grade of paper.

M. W. LYON, JR.

RAFINESQUE

Rafinesque's Kentucky Friends. By HARRY B. WEISS. Privately printed. Highland Park, New Jersey, 1936. 70 pp., 25 portraits. For sale by the author (price $7.50), Highland Park, New Brunswick, N. J.

DAVID STARR JORDAN thus characterizes the subject of this little book, "Brilliant, erudite, irresponsible, fantastic, he wrote . . . of the fishes of the Ohio River with wide knowledge, keen taxonomic insight, and a hopeless disregard of the elementary principles of accuracy. Always eager for novelties, restless and credulous, his writings have been among the most difficult to interpret of any in ichthyology."

Constantine Samuel Rafinesque (1783–1840) was born at Constantinople, the son of a French father and of a German mother born in Greece. His early boyhood was spent mainly in Italian seaport cities. In 1802 he came to Philadelphia, but returned to Italy in 1805. The next 10 years seem to have been spent in scientific work in Sicily, but in 1815 he came to America again. In Philadelphia he met Mr. John D. Clifford, of Lexington, Kentucky, and was invited by him to visit his home in Lexington. In May, 1818, Rafinesque started, making the trip by stage, boat and on foot. Clifford persuaded Rafinesque to come to live with him in Lexington and promised to procure for him a professorship in natural history in Transylvania University. Rafinesque returned to Philadelphia, shipped his books and collections to Lexington, and himself returned there in the summer of 1819.

Dr. Weiss devotes 14 pages of his book to Rafinesque's life in Kentucky: to his teaching in the university, to his scientific trips and collections and to his scientific writings and publications while there, and particularly to his relations with the people among whom he lived. Because of his exaggerated temperament, he was a very difficult person to live and work with, especially after he developed a persecution complex. But all this is set out in Dr. Weiss's sketch and need not be gone into further.

Rafinesque was a talented artist, as is vouched for by the 25 sketches which are reproduced in the book. He seems to have been in the habit of sketching his friends or acquaintances at any time and place. Among these sketches are drawings of his mother, sister, and either of his wife or her sister. The others are chiefly of men and women prominent in the political and social life of Lexington and of Kentucky. The unidentified portraits are mainly of girls and young women, possibly children of his friends.

One is disappointed not to find any record of the whereabouts of the original sketches. These sketches have little value to the man interested in Rafinesque's scientific work. But as documents in the history of Lexington and of Kentucky of the time covered by Rafinesque's life in Lexington they are of undoubted value.

E. W. GUDGER

IN HONOR OF PROFESSOR HONDA

Professor K. Honda Anniversary Volume. October, 1936. Sendai, Japan.

THIS volume of more than 1,100 pages is published in the series of Science Reports of the Tôhoku Imperial University, Sendai, Japan, as a tribute to Professor Kôtarô Honda, now president of the university,

[1] One member of the Danish family Bering, using the name Bierring, served in the American Navy during the Civil War, and his son was president of the American Medical Association recently.

on the completion of twenty-five years of his professorship. The Science Reports are so well known to scientists working along many varied lines that nothing need be said to emphasize and enlarge upon their value and worth. The present volume is an outstanding one. It signalizes not only the personal efforts and accomplishments of Professor Honda, but also the great contributions of his pupils in the university and in the world-renowned Research Institute for Iron, Steel and Other Metals.

Of the 97 papers, 24 are contributions from American and European workers. A wide range of subjects is discussed, including metallurgy, magnetism, mechanical properties of materials, chemistry, spectroscopy, x-rays, mechanics, mathematics, meteorology and instrument design. However, 54 of the papers deal with metallurgy and magnetism, reflecting Professor Honda's influence in these fields. Many of the papers, especially those by American and European contributors, are in the nature of theses summarizing work which has extended over a long period. For this reason, they should prove especially valuable for reference.

The volume contains a bibliography of the 167 scientific papers and 8 books written by Professor Honda and a brief biography. Unlike our own custom in similar volumes, no photograph is included.

LYMAN J. BRIGGS

SPECIAL ARTICLES

A RECENTLY ISOLATED STRAIN OF POLIOMYELITIC VIRUS

IN the winter of 1934 an outbreak of poliomyelitis with a high mortality rate occurred in Sacramento, California. Fresh cord from a fatal case was obtained through the courtesy of Dr. Paul Guttman, of the Sutter Hospital, and proved to contain poliomyelitic virus upon inoculation of a monkey. The animal became completely paralyzed and was sacrificed in 6 days after injection of 2 cc of the 10 per cent. suspension intracerebrally and 8 cc intraperitoneally. The virus could be transmitted in series to other monkeys, and since then has been carried successfully through eight generations. Because of the fulminating and severe course of the outbreak, largely among high-school students in Sacramento, it was thought of interest to make a comparison of this virus with the monkey passage strain originally received from the New York City Health Department, and with several others on hand, especially one (Jackson) that had previously been recovered during the summer of 1934 from a fatal case in San Francisco.

The disease in the monkey after intracerebral inoculation was clinically similar to that usually noticed with the monkey passage strain, increased temperature, excitability, tremor, staccato voice, followed by flaccid paralysis of the extremities and complete prostration within 6 to 11 days after injection. The incubation period was usually 6 to 7 days, similar to that of the more active passage strain, but in making comparison it should be recorded that 10 per cent. instead of 5 per cent. cord was generally used as the basic suspension. The former upon titration has proven viable in a 1–200 to 1–400 dilution. The passage strain on the other hand could be titrated to a dilution of 1–3200 from a 5 per cent. suspension, so that the more recently isolated strain lacked the higher infectiousness shown by the older adapted one. The Jackson also lacked this more active virulence, although on one occasion it was potent in a 1–800 dilution.

Recently Trask and Paul[1] have reported a slight variation in a strain of poliomyelitic virus isolated from a case in southern California during the same year, 1934. Their strain showed an affinity for the peripheral nerves with greater and more constant regularity than with the other strains tested. In like manner this new Sacramento virus also seemed to have this property, since it was found unexpectedly that very small quantities of filtered suspension could produce the disease with typical paralysis when given intradermally. In attempting to immunize 2 monkeys, one was given 0.5 and 1 cc of filtered virus (Berkefeld N filtrate), respectively, one week apart, and the other 0.2 and 0.6 cc, respectively, at a 9-day interval. Both animals developed poliomyelitis within a week after the second inoculation. At the same occasion five other animals were immunized to the active passage strain by the same route, being given larger doses (1 to 5 cc) of unfiltered material over a 5-week period without any casualties.

Cross neutralization tests were performed to determine any possible serological differences with the other strains. From previous experiments made at various times, no difference in cross immunity had ever been noticed between the monkey passage strain and several recently isolated human strains (N. Y. and Fl) kindly sent by the Rockefeller Institute and by Dr. J. R. Paul, of Yale University, respectively. Any differences were those of lower virulence or of inability to produce the disease unless with large doses.

Serum was obtained from 2 monkeys, Nos. 1334 and 1499. The former (1334) was immunized to the Sacramento strain of virus and the latter had recov-

[1] J. D. Trask and J. R. Paul, *Jour. Bacteriol.*, 31: 527–530, 1936.

ered from an attack of the disease and was then hyperimmunized with the same strain. Three separate tests with serum of No. 1334 and two with serum of No. 1499 taken at different periods during immunization all failed to protect against the standard amount (1–25) of monkey passage virus, while on the other hand the serum of each animal neutralized its homologous virus. Neutralization tests were also made, using the Sacramento strain diluted either 1–10 or 1–25 against serums of animals immunized to the Jackson and to the passage strains of virus, respectively. Neutralization occurred in 4 of the 5 trials, including one using hyperimmune horse serum of high potency.[2]

Tests for cross tissue immunity were then made in which 3 animals were used that had recovered from an attack of the disease after receiving the Sacramento strain and 2 that had been immunized to this same virus. All 5 monkeys were given intracerebral injections of the passage virus, three receiving a 1–50 dilution and 2 the undiluted 5 per cent. suspension. Two animals withstood the inoculations and 3 became paralyzed. The former were both animals which had recovered from the first attack of the disease, while only one of the group was among the less resistant series.

Three monkeys immunized to the monkey passage strain over a long period of time and resistant to intracerebral inoculation of their homologous viruses were also given similar inoculations of the Sacramento strain. Two of these remained well, although one developed a high temperature, accompanied by nervousness and excitability, while the third became severely paralyzed in both legs, with partial arm paralysis. The test doses in each case were usually large, 2 cc intracerebrally and 10 or 15 cc intraperitoneally of a 10 per cent. suspension.

Neutralization tests with serums from 3 monkeys immunized against the Jackson strain showed protection against the passage virus when used in a 1–25 dilution, while 2 animals (Nos. 1354 and 1371) immune to the Jackson strain were also immune after intracerebral inoculation of the more potent heterologous virus, in a 1–25 dilution. All control animals succumbed to this same dose. In all respects except high potency the Jackson strain seemed immunologically similar to the passage virus.

On the other hand, there is apparent difficulty in the interpretation of the results with the Sacramento strain. While there is a certain degree of cross protection, it is mainly manifest in one direction. Protection was noted when serums were used from monkeys immunized to the passage virus or, with one exception, when animals had been immunized to this strain. While the serum of this latter animal protected against its homologous strain of virus and it was also immune against intracerebral inoculation, yet neither its serum neutralized the Sacramento strain nor was the animal itself resistant against a massive dose of the latter virus.

In contradistinction, tests with the Sacramento serums never protected against the passage virus, and 60 per cent. of the immune Sacramento monkeys lacked tissue immunity against this same strain.

From the evidence presented and from accumulating reports of others, it appears that not all strains of poliomyelitic virus are quantitatively or even qualitatively similar. References are either to a quantitative difference, as shown by the lower invasive power of the more recently isolated strains when compared with the far more virulent monkey passage virus, as recently reported by Kessel and his associates[3] or to comparisons of the differences in neutralizing ability of immune serums against recently isolated or passage strains.[4, 5, 6, 7] Burnet and Macnamara,[8] however, recorded a qualitative difference between their Australian poliomyelitic virus and that of the MV strain of the Rockefeller Institute, as have Paul and Trask[9] in this country for two human strains recovered in the eastern United States. The former reported that two monkeys recovered from an attack of poliomyelitis induced by the Australian virus were not immune to the MV strain, while one animal partially paralyzed by the latter succumbed to a later inoculation of the local virus. These results are very similar to those presented here for the new California strain. Somewhat similar properties are shown, except that the latter strain also offers the affinity for the peripheral nerve trunks not so readily shown by the others, except for the one recently reported by Trask and Paul.[10] Since their virus was also recovered in California during the same year, although from a widely separated locality, one might expect a closer relationship. Erber and Pettit[11] in France have alluded to a possible lack of identity among 4 separate recently isolated strains. Their results were not sufficiently definite, however, to draw any real distinctions in differentiation.

[2] B. F. Howitt, SCIENCE, 80: 621–622, 1934.

[3] J. F. Kessel, R. VanWort, R. T. Fisk, and F. D. Stimpert, *Proc. Soc. Exp. Biol. and Med.*, 35: 326, 1936.

[4] E. R. Weyer, *Proc. Soc. Exp. Biol. and Med.*, 29: 289, 1931.

[5] S. Flexner, *Jour. Am. Med. Asn.*, 29: 1244, 1932.

[6] B. F. Howitt, *Jour. Infect. Dis.*, 53: 145, 1933.

[7] J. R. Paul and J. D. Trask, *Jour. Exp. Med.*, 61: 447–464, 1935.

[8] F. M. Burnet and J. Macnamara, *Brit. Jour. Exp. Path.*, 12: 57–61, 1933.

[9] J. R. Paul and J. D. Trask, *Jour. Exp. Med.*, 58: 513–529, 1933.

[10] *Loc. cit.*

[11] B. Erber and A. Pettit, *Compt. rend. Soc. de biol.*, Paris, 117: 1175–1178, 1934.

Inasmuch as decided immunological differences have been distinguished between separate strains of other viruses such as those of equine encephalomyelitis[12] and of human encephalitis[13, 14] wherein the same clinical manifestations are given by the respective strains within each group of viruses, it may well be worth considering such a possibility for the virus of poliomyelitis. Regional differences in strains, not only in respect to invasive power or potency but in respect to qualitative dissimilarity of the antigenic structure, might help to account for the mildness of an outbreak in a certain section as compared to the severity in another. While undoubtedly the high immunity rate of the community as a whole, regardless of how accomplished, largely accounts for the comparatively low morbidity in poliomyelitis, yet sudden outbreaks with an unexpectedly high mortality rate do occur and might well be ascribed to a virus of slightly different immunological makeup combined with high infectiousness. In judging the results of serum therapy, therefore, account should be taken of possible differences in virulence of the virus in different regions combined with a possible difference in antigenic structure. A population ordinarily exposed to a milder strain of virus might not be resistant to one of greater potency and consequently would not respond as well to treatment with serum from those immune to the former strain.

In conclusion, a recently isolated strain of poliomyelitis virus has been found to possess certain immunological properties combined with a slight difference in tissue reactions that suggest the possibility of finding both a qualitative as well as a quantitative difference in the strains of virus causing poliomyelitis.[15]

B. F. Howitt

The George Williams Hooper Foundation
University of California
San Francisco

RELATION OF CERTAIN VIRUSES TO THE ACTIVE AGENT OF THE ROUS CHICKEN SARCOMA[1]

The belief held by some investigators that mammalian tumors are caused by viruses is due largely to the demonstration by Rous[2] that the tumor-producing agents of some chicken sarcomas do not lose their activity when passed through a Berkefeld filter. The evidence in support of this hypothesis has been set forth in detail recently by Andrewes[3] and Rous,[4] and will not be discussed here. Instead, we wish to report some observations distinguishing the active agent of the Rous chicken sarcoma No. 1 from two well-recognized virus diseases: vaccinia, an animal infection, and tobacco mosaic, a disease of plants.

The lipid fraction of the Rous chicken sarcoma is capable of reproducing the tumor in a high percentage of inoculated animals.[5] Allard[6] tested the effect of various lipid solvents on the dried virus of tobacco mosaic. Very few of them affected its activity, and the lipid extracts were always inactive. We have been unable to find reports of similar experiments with the virus of vaccinia, though many attempts to use these solvents as disinfecting agents have been made.[7]

The work of Stanley,[8] with the virus of tobacco mosaic disease, and of Northrup,[9] with bacteriophage, indicates that the infective agents in these diseases are protein in nature, and therefore we should not expect to recover them in the lipid extracts by the technique we are using. The experiments to be described were conducted with two possibilities in mind. It is conceivable that the active agent of the tobacco mosaic disease might be merely adsorbed by the protein crystals, though this would seem improbable in view of Stanley's repeated recrystallization of the proteins. In addition, they will serve as a check on the work done in this department with the Rous chicken sarcoma, as it is possible that a protein, representing the active principle, has been carried along in the lipid extract. The solvents used would seem to obviate this possibility, and chemical and biological tests have failed to reveal its presence.

The material used in the vaccine virus experiments consisted of three lots:[10] first, calf skin pulp, frozen promptly and kept in this condition until the time of the experiments; second, calf pulp dried immediately

[12] B. F. Howitt, *Jour. Immunol.*, 29: 319–341, 1935.

[13] L. T. Webster and G. L. Fite, *Jour. Exp. Med.*, 61: 411–422, 1935.

[14] R. Kawamura, M. Kodama, T. Ito, T. Yasaki and R. Kobayakawa, *Arch. Pathol.*, 22: 510–523.

[15] Aided by grants from the anonymous Poliomyelitis Donation of the Hooper Foundation and from the President's Birthday Ball Commission for Infantile Paralysis Research.

[1] From the Department of Pathology, College of Physicians and Surgeons, Columbia University, New York City. This investigation has been aided by a grant from the Josiah Macy, Jr., Foundation.

[2] Peyton Rous, *Jour. Exp. Med.*, 13: 397, 1911.

[3] C. H. Andrewes, *Lancet*, 2: 64 and 117, 1934.

[4] Peyton Rous, *Jour. Cancer Res.*, 28: 233, 1936.

[5] James W. Jobling and E. E. Sproul, Science, 84: 229, 1936.

[6] H. A. Allard, *Jour. Agric. Res.*, 6: 649, 1916.

[7] W. Palmer Dearing, *Am. Jour. Hygiene*, 20: 432, 1934.

[8] William M. Stanley, *Phytopathology*, 26: 305, 1936.

[9] John D. Northrup, Science, 84: 90, 1936.

[10] We wish to express our appreciation to Dr. Clowes, of Mulford and Company, to Dr. Reichel, of Sharpe and Dohme, and to Dr. Beard, of Lederle and Company, for the large amounts of vaccine virus which we found necessary in these experiments.

in the Lyophile apparatus; and third, chick embryo virus, which was frozen while fresh and dried *in vacuo*. In no instance had preservatives been added. The frozen material was thawed and ground to a fine pulp by passage through a meat grinder. It was then placed in tubes, frozen with carbon dioxide snow and desiccated in the Flosdorf-Mudd Lyophile apparatus. In the first experiment carbon tetrachloride was used as a solvent; in the second, petroleum ether; and in the third, the solvent consisted of equal parts of petroleum ether and chloroform, as experience with chicken sarcoma has shown this mixture to be a better extractive. However, with the technique described, all three solvents have extracted the active principle from the sarcoma. In each instance the dried, finely ground material was put in a flask and extracted 3½ hours with four changes of the solvent in a water bath kept at 37° C. During extraction nitrogen was bubbled through the mixture with the double purpose of keeping it agitated and driving out the air. The solvent was filtered until clear and evaporated to dryness in a stream of nitrogen at 37° C. under negative pressure. The dried lipid extract was divided into three portions, one of which was emulsified in distilled water; the second, in a 10 per cent. saline extract of rabbit skin, as this was to be the test animal; and the third, in a 0.5 per cent. casein solution. The casein solution was added because it has proved capable of preserving or augmenting the activity of the lipid from the Rous sarcoma, which was inactive when injected alone, and the skin extract because of the frequency with which lesions occur in this tissue. Each preparation was tested on the skin and cornea of rabbits.

To test the activity of the original material, some of the dried but unextracted tissue was suspended in water at 37° C. for two hours. It was then centrifuged and the supernatant fluid tested on the cornea and skin of rabbits. After removal of the solvent, an extract of the treated pulp was prepared in a similar manner to learn if the virus had been destroyed by the solvent.

Briefly, the extract of the untreated virus was found to be quite active on both the cornea and the skin of rabbits, while the lipid extracts failed to produce any lesion. The water extract prepared from the lipid extracted residue was also active. Guarnieri bodies were present in the corneas of the rabbits inoculated with extracts of the untreated dried virus, and of the extracted tissue residue, but not in those inoculated with the lipid preparations. Identical results were obtained in three experiments.

The air-dried tobacco mosaic virus No. 1[11] and the plants inoculated in our tests, the *Nicotiana glutinosa* *L.*, were obtained from the Boyce Thompson Institute through the kindness of Dr. Helen Beale.[12] The local-lesion method[13] was used in inoculating the plants. In these experiments, the technique of preparing the extracts was similar to that used with vaccine virus and Rous chicken sarcoma. In the first experiment the solvent used was carbon tetrachloride and in the second, petroleum ether. In both experiments the disease was produced with water extracts of the unextracted and the extracted dried leaves, but there was no evidence of it in the plants inoculated with the lipid extracts.

If we accept the rather generally held view that a disease-producing agent which retains its activity after being passed through a Berkefeld filter should be termed a virus, then we must believe that viruses should be classified according to their chemical properties—as proteins, lipids, etc.—and in the lipid group place the Rous chicken sarcoma. However, it would seem more logical to look upon the agent causing chicken sarcoma not as a virus but as a product of abnormal cell metabolism. It is most unlikely that the lipid can reproduce itself, and therefore it seems probable that it possesses the ability when injected into normal animals under proper conditions to stimulate normal cells to produce a similar substance and thus perpetuate the disease. Certainly our failure to produce disease with the lipid extracts of the two viruses examined indicates that they are of a different chemical nature.

J. W. JOBLING
E. E. SPROUL

INFLUENCE OF DEUTERIUM OXIDE ON PHOTOCHEMICAL AND DARK REACTIONS OF PHOTOSYNTHESIS

IN experiments previously reported,[1] cells of the alga *Chlorella* liberated O_2 about 0.41 as rapidly in buffers prepared with 99.9 per cent. D_2O (deuterium oxide or heavy water) as in those prepared with H_2O (0.02 per cent. D_2O); CO_2 was supplied in excess and illumination intensity was 6,500 lux (correction from 2,000). To study the influence of D_2O on different stages of the photosynthetic process, additional experiments have been made with the manometric technique previously described. Warburg's[2] No. 9 buffer, prepared with potassium salts, was used in the light intensity experiments, and 0.1 M $KHCO_3$ alone was used in the experiments with intermittent light.

[11] James Johnson, *Wisconsin Agric. Exp. Sta. Res. Bull.*, 76, 1927.

[12] We wish to express our great appreciation to Dr. Helen Beale, not only for supplying us with material, but also for teaching us the technique used in this type of experiment. Without her assistance the work would have been much more difficult.

[13] Francis O. Holmes, *Bot. Gaz.*, 87: 39, 1929.

[1] J. Curry and S. F. Trelease, SCIENCE, 82: 18, 1935.

[2] O. Warburg, *Biochem. Zeit.*, 100: 230–270, 1919.

Preparations were exposed to continuous light for 15 minutes before observations were begun, and all rates were corrected for respiration by means of tests in darkness. Light for the first series of experiments was furnished by a bank of Mazda lamps placed under the manometer vessels. Intensity of illumination was measured at the bottoms of the vessels by means of a Macbeth illuminometer. Different intensities were obtained by varying the wattage of the lamps and the distance between them and the vessels.

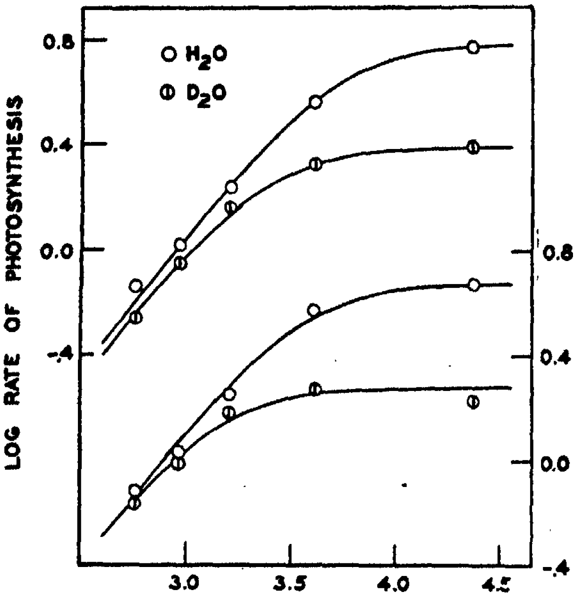

FIG. 1

Data from two typical experiments[3] are plotted in Fig. 1. (The temperature for the upper pair of curves was 23.0° C.; for the lower, 24.9° C.) The smoothed curves were drawn according to the critical equation proposed by Smith,[4] $KI = p/(p^2_{max.} - p^2)^{1/2}$, in which p is the rate of photosynthesis at light intensity I, K is a constant that locates the curve on the I axis, and $p_{max.}$ is the asymptotic maximum rate of photosynthesis.

It may be seen that with high light intensity, when the velocity of the dark chemical reaction determined the rate of the total reaction, D_2O strongly depressed the rate of photosynthesis. But with low light intensity, when the speed of the photochemical reaction determined the rate of the whole process, D_2O exerted but relatively little influence. These results indicate that D_2O retarded the rate of the dark reaction of photosynthesis, but had little, if any, effect on the photochemical stage of the process.

Subsequent experiments with intermittent illumination furnished additional direct evidence for this conclusion. Light intensity of 41,400 lux at the bottoms of the manometer vessels was obtained by means of a system comprising a 500-watt projection lamp, a series of lenses and a mirror. For obtaining intermittent illumination, a solid disk with a suitable opening was rotated vertically in front of the light source at 900 r.p.m., so that the cells were exposed to 15 flashes of light per second—each flash being followed by a relatively long dark period. Light was available to 50 per cent. or more of the cells in each vessel about 6.8 per cent. of the time. The duration of a single flash was about 4.5×10^{-3} seconds, and the length of the dark interval was about 62.2×10^{-3} seconds. The temperature was 23.9° C.

Representative results from one of these experiments are plotted in Fig. 2, which shows evolution of

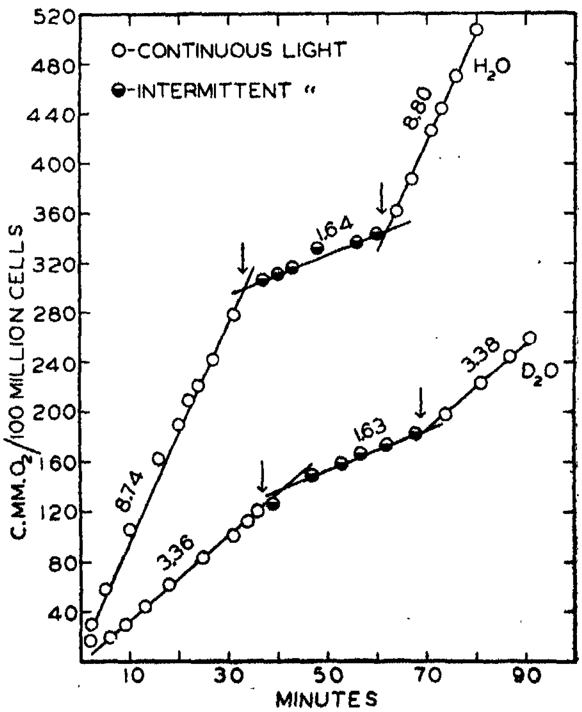

FIG. 2

O_2 from 100 million cells as a function of total time. The number near each curve gives the slope or rate of photosynthesis. Since the portions of the curves representing O_2 evolution in intermittent light are essentially parallel, it is evident that when the dark period after each light exposure was long enough to allow the dark reaction to proceed to completion in D_2O, the rate of photosynthesis was as great in D_2O as in H_2O. Apparently the dark reaction proceeded as far in D_2O as in H_2O, although its velocity was lower in the former. Additional experiments of the

[3] F. N. Craig and S. F. Trelease, *Amer. Jour. Bot.*, 24: in press, 1937.

[4] E. L. Smith, *Proc. Nat. Acad. Sci.*, 22: 504–511, 1936.

same type have shown that these results are reproducible. It therefore appears that the principal influence of D_2O on photosynthesis is to retard the dark reaction, and that D_2O affects the photochemical stage of the process very little, if at all.

Through the use of the rotating disk the amount of light received by the cells per minute was reduced approximately 93 per cent., but in neither D_2O nor H_2O was photosynthesis reduced commensurately with the amount of illumination. Computations based on the data plotted in Fig. 2 show that per unit amount of light supplied, the amount of photosynthesis was increased in intermittent illumination approximately 175 and 615 per cent. in H_2O and D_2O, respectively. Since the methods employed to obtain intermittent illumination differed somewhat from those of other investigators,[5] the values given here can not be compared with the data published by these writers for photosynthesis in H_2O.

Perhaps the most important implication of our experimental results is that H_2O as well as D_2O enters into the dark stage rather than into the photochemical stage of photosynthesis.

We hope to present elsewhere a detailed account of these and other experiments in which the D_2O concentration, CO_2 concentration, temperature and ratio of dark interval to light interval were varied.

ROBERTSON PRATT
FRANCIS N. CRAIG
SAM F. TRELEASE
LABORATORY OF PLANT PHYSIOLOGY
COLUMBIA UNIVERSITY

[5] R. Emerson and W. Arnold, *Jour. Gen. Physiol.*, 15: 391–420, 1932; 16: 191–205, 1932. Warburg, *loc. cit.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE METHOD OF MEASURING ROTATIONAL SPEEDS

THE development of the ultracentrifuge has made it necessary to measure rotational speeds over wide ranges. In some of our previous experiments the speed was varied from about a hundred to over twenty thousand revolutions per second. Usually the working speeds are between 500 r.p.s. and 3,000 r.p.s.[1] Several different methods of measuring speeds of rotation in this range may, of course, be used, but in practice they are comparatively complicated and require special or expensive equipment. Also, as in the case of some forms of the stroboscopic method, care must be taken by the observer to distinguish between the fundamental and its harmonics.

A method is described in this paper which is practically free from the above objections and is almost ideally suited to the measurement of rotational speeds over much wider ranges than necessary at present. Fig. 1 shows a schematic diagram of the apparatus.

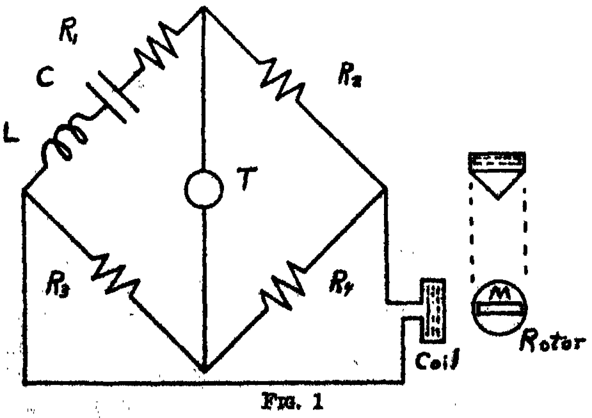

FIG. 1

A small magnet M fastened to the high speed rotor or driving turbine induces an alternating current in the coil, which is connected across a bridge that can be balanced at only one frequency. An inspection of the circuit shows that the bridge will balance when

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \text{ and } Lw = \frac{1}{Cw} \text{ or } N = \frac{1}{2\pi\sqrt{LC}}$$

where R_1, R_2, R_3 and R_4 are non-inductive resistances; L inductance, C capacity and N the frequency of the alternating current in the bridge. Therefore, the procedure in measuring the rotational speed of the rotor is simply to vary either C or L until T indicates that the bridge is balanced. Then from the known value of L and C the number of revolutions per second N is computed. The indicating instrument T may be a loud speaker, telephone receiver, thermocouple galvanometer, etc., used either with or without an amplifier, depending upon the sizes of the rotating magnet and coil as well as their distance apart. In our experiments the magnet was either a piece of sewing needle (1 to 2 cm in length) or a small cobalt steel magnet. These small magnets when properly mounted do not disturb the balance of the high-speed rotors or turbines. The resistances $R_2 = R_4 = 300$ ohms, and $R_3 = 100$ ohms. They were ordinary non-inductive wire-wound resistances. $R_1 = 100$ ohms and included the resistance of the inductance L. Three fixed mica condensers were used in various combinations as the capacity C, while L was a variable inductance (5 to 25 millihenries). The capacity could thus be varied in large steps, while L could be varied continuously. Table I shows values for the rotational speed com-

[1] Beams and Pickels, *Rev. Sci. Instruments*, 6: 299, 1935.

TABLE I

N Bridge	N Stroboscope
551 r.p.s	545 r.p.s.
627	612
870	858
1108	1090
1244	1250
1355	1333
1417	1412
1548	1540
1745	1738
1915	1936
2156	2182

puted from settings on the bridge and from simultaneous stroboscopic determinations made with a rotating slotted disk. It will be observed that they are in good agreement. As a matter of fact, the values obtained stroboscopically were much less precise than those obtained with the bridge. The settings on the bridge were so "sharp" that the precision was limited only by the precision with which the scale on the inductance could be read. With fixed capacities, the scale on the inductance can be calibrated directly in revolutions per second.

The above method therefore possesses the following advantages: (1) The apparatus is inexpensive, simple to operate and easily obtainable or constructed. (2) The rotational speed is read directly, and no special skill is required of the observer, since only one frequency will balance the bridge. (3) Its calibration does not change. That is, the settings are independent of the strength of M and the position of the coil. (4) The readings can be made about as accurately and quickly as desired, and this makes it possible to follow rapid fluctuations in the speed of the rotor. (5) The balance of the bridge also may be used indirectly to control the rotational speed when this is desirable.

It is indeed a pleasure to acknowledge a grant from the Rockefeller Foundation for the development of the ultracentrifuge.

L. B. SNODDY
J. W. BEAMS

UNIVERSITY OF VIRGINIA

INSTRUMENT TENTS

SEVERAL visitors at this laboratory have regarded with interest a simple arrangement which is in use here for protecting a large spectrophotometer from the accumulation of dust or exposure to spilled material or humid atmosphere. At the risk of duplicating any current information, one visitor's suggestion that a brief note be published on the matter has been adopted.

Ordinary cloth sheets, towels or black cloths, placed over colorimeters, microscopes, spectroscopes or other optical instruments afford little more than superficial protection against moisture, and defeat another purpose by actually leaving deposits of dust and lint upon exposed optical surfaces. Yet when an instrument is in frequent use, or must remain for some hours in an undisturbed position, or is without a wooden case (all three of which contingencies apply to this spectrophotometer) it is desirable to protect it from dust and moisture. To meet such needs, we have had a large tent of specified shape and dimensions constructed out of yellow oiled silk, such as is used in wet surgical dressings, shower-curtains, etc.; some Cellophane derivative might serve as well.

Tents of such material in any specified shape or size can be constructed readily, usually by local companies. The material is transparent enough that the instrument may be seen when covered, tough, pliable, washable, lasting, light enough to be removed and replaced readily without risking accidental disturbances to adjustment of verniers, settings, mirrors, etc., and affords gratifying protection against dust and moisture.

For the covering of large instruments, use may be made of the simple contrivance employed here: a narrow strip of canvas, sewn along the midline at the top of the spectrophotometer-tent, supports a series of small metal rings, by which the whole tent is suspended by strings to a light dowel extending the length of the tent. The dowel is in turn suspended from the ceiling by a pair of small cords running over pulleys. Thus when the instrument is to be used, the light tent is easily drawn up and hung out of the worker's way. When desired, it can be readily relowered over the instrument. It is important that the tent cover the instrument completely, its bottom edges meeting the table surface.

DENIS L. FOX

SCRIPPS INSTITUTION OF OCEANOGRAPHY
LA JOLLA, CALIF.

BOOKS RECEIVED

AKELEY, MARY L. J. *Restless Jungle.* Pp. xiii + 313. Illustrated. McBride. $3.00.

BELL, E. T. *Men of Mathematics.* Pp. xxi + 592. 30 plates. Simon and Schuster. $5.00.

HAMILTON, LEICESTER F. and STEPHEN G. SIMPSON, Editors. *Talbot's Quantitative Chemical Analysis.* Eighth edition. Pp. xiv + 297. 12 figures. Macmillan. $2.50.

HOFFMAN, FREDERICK L. *Cancer and Diet; With Facts and Observations on Related Subjects.* Pp. xx + 767. Williams and Wilkins. $5.00.

HORNEY, KAREN. *The Neurotic Personality of Our Time.* Pp. xii + 299. Norton. $3.00.

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ENGINEERING IN AN AMERICAN PROGRAM FOR SOCIAL PROGRESS[1]

By Dr. KARL T. COMPTON

PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IT is a great pleasure for me, on this notable occasion, to bring you the congratulations of your sister institution which I serve and to express the cordial best wishes for the even greater success of your engineering school in the next twenty-five years, which is the confident hope of your thousands of colleagues in sister educational institutions and in the engineering profession.

The Johns Hopkins University has been a pioneer and an example in much of the finest development of education in America, notably in such fields as chemistry, physics and medicine, and in postgraduate education. It attained this preeminence through concentration of its resources in a limited number of basically important fields, instead of dissipating its energies in an attempt to spread thinly over the whole field of knowledge or to pursue the ever appearing will-o-the-wisps of educational fashions. Its School of Engineering, though one of its younger departments, is of this basic character and has achieved distinction through the high ability and character of its staff and through its policy also of limiting its range of activities to those fundamental fields of engineering which it can cultivate with distinction within the limitations of its resources. While we all hope that ways and means may be found to increase its resources commensurately with its proven worth and opportunities, I trust that its wise policy of subordinating expansion to excellence will persist.

[1] Address on Commemoration Day at the Johns Hopkins University, February 22, 1937, celebrating the twenty-fifth anniversary of the founding of the School of Engineering at the Johns Hopkins University.

I would pay special tribute at this time to your two leaders, whom I am proud to claim as my friends. One of these, your dean, has served the School of Engineering from its beginning and has impressed on it his qualities of scholarship, of culture and that type of public service which he himself exemplifies in his important "extra-curricular" professional activities. The other is your "year-and-a-half"-old president, who is bringing to the service of this university those unusual qualities of clarity of judgment, creative imagination, decisive courage and statesmanship and warm loyalty to men and to objectives that are true and worthy, which I have so admired as I have come to know him in his leadership of organized science in the better performance of much-needed social service.

About a year ago I had occasion to discuss Science in connection with a symposium on "An American Program for Social Progress," arranged by the National Industrial Conference Board. On this occasion it seems appropriate to speak on the closely related subject of "*Engineering in an American Program for Social Progress.*" For this twenty-fifth anniversary of the founding of the School of Engineering of this great university naturally turns our thoughts to an appraisal of the rôle of engineering in our society and to an attempt thereby to chart a wise course for the future, whereby engineers and engineering can best perform *that service to the public which is the justification for* their existence.

It is obviously not my function to chart the course for engineering at Johns Hopkins University. This is the responsibility of your trustees and administrative officers. But I can review some factors which are important in the consideration of engineering education, whether here or elsewhere, and which should be considered in the formulation of policies by any body which has to do with engineering. Government, university, business, labor, agriculture and the public generally all have a vital concern in these questions, as I shall show.

The outline of my discussion of these matters is exceedingly simple, for it is based on just two questions: "What elements are involved in the American program for social progress?" and "What is the proper rôle of engineering in each feature of this program?" But before dealing with these questions, it is well to consider briefly what engineering is and how it has developed.

On the walls of the national headquarters of the engineering societies in New York there hangs the definition: "Engineering is the art of directing men and controlling the forces and materials of nature for the benefit of the human race." This is so broad a definition that some may question its justification. But while there are many who do not call themselves engineers (as, for example, the President of the United States or the Secretary of Agriculture or the president of a steel company or the head of a labor union) "who direct men and control (or try to control) the forces and materials of nature for the benefit of the human race," nevertheless such men are really operating to a great extent in the field of the engineer. And to the extent to which they follow the methods of the engineer—in basing policies upon facts, in utilizing knowledge to achieve results, in depending on law rather than hunch, in giving attention to foundations before erecting superstructures, in using imagination disciplined by experience, in thinking through to the goal before starting on the way—to this extent will their efforts be "for the benefit of the human race."

That quality of the engineer of achieving results has been so notable as to have received recognition in the dictionary in the coinage of a new verb, "to engineer." For it is common parlance to say "he engineered a deal," or "we need some one to engineer this project." Such phrases reflect the common realization of the public that the methods of the engineer are sound and successful. The fact that this realization is tacit and almost subconscious is all the more evidence that it is derived from a long background of experience of undertakings successfully carried through by engineers.

It is this quality of performance in matters of practical importance that distinguishes the engineer from his close relation, the scientist. The pure scientist concerns himself with the study of the materials, forces and phenomena of nature. The applied scientist bridges the gap between science and its use, and his function is to interpret and extend in order that utility may ensue. The engineer bridges the gap between science and the public, and his function is to develop the applications of science in such manner that they may fit beneficially into the existing organization of civilization.

It is significant that the engineer is a relatively new actor on the stage of world progress: he is both the product and the cause of our *technological age.* I would not imply that there were no engineers in past ages; Archimedes, the Roman road and aqueduct builders and Leonardo da Vinci were great engineers. But as a profession, engineering is of relatively recent origin. Great universities in Europe have existed since antiquity, with their professional schools of law, medicine and theology. In America, Harvard celebrated last fall its three hundredth anniversary. But Rensselaer, the oldest engineering school in this country, was founded only 113 years ago, my own institution 72 years ago and your school only 25 years ago. Although there are now 155 degree-granting engineering schools in the United States, enrolling about one tenth of the country's college student population, most of these schools are relatively young and all started

small. Thus, compared with other great professions, the systematic training of engineers scarcely extends beyond the lifetimes of the older men now in the profession. This fact serves to enhance the significance of the importance and success which engineering has achieved.

During this less than a century of development, the character of engineering education has undergone important changes. In the early days the professional curriculum consisted of pure science, the applied science of the day and the techniques of practical work in shops or in the field. As great industries developed, based on technological advances, the curriculum took on more of systematic training in the processes and techniques of these industries, became more crowded with newer and newer specialties, with some tendency to crowd out the basic sciences and much pressure to stuff the student with all the factual knowledge and techniques which he might later be called upon to use. This trend finally broke for two reasons: it became impossibly unwieldy and it became out of tune with industrial demands in the following manner.

In their early development, industries had to depend largely on the engineering schools to provide both the knowledge and the technical, often manual, training which their operations required. But now the larger industries can, and prefer, to do much of the training of their new employees in the particular techniques and operations which they use. Their great demand is for young engineers who are so well grounded in the sciences and in the fundamental theories of engineering as to be capable of grappling effectively with the new problems and ever-advancing arts that are associated with technological progress.

So the recent tendency of the engineering schools has been to reduce emphasis on shop practices—leaving most of these to the technical or trade schools and to apprentice training courses in the industries themselves; also to postpone the more specialized training into postgraduate years; and to concentrate chiefly on basic science and fundamental engineering, together with more attention to the economics and social science which are becoming more and more the concern of the engineer. In this program, such specialization as remains in the undergraduate curriculum is more for the purpose of training the student how to specialize than for producing a specialist.

We thus have emerging, to meet present and future needs, this type of undergraduate engineering school. In favorable situations such schools are being extended to rapidly increasing attention to postgraduate training in specialties and in research, and coincidentally, increasing activity in assisting industry to solve some of its more obscure or forward-looking problems.

But industry requires both engineers and technicians—about four technicians to every engineer, according to a recent survey by the Society for the Promotion of Engineering Education. The situation is too complex for one and the same school to try to train both engineers and technicians, and do a good job with either. So the latter function is being more and more taken over by the industries themselves and by the technical and trade schools, as distinguished from the engineering schools. Naturally, however, all gradations between these extremes exist among the numerous engineering and technical schools of the country.

In this classification, the School of Engineering of Johns Hopkins University lies definitely in the category of the progressive engineering school. Undoubtedly this is due both to its youth and to the high scientific ideals of its founders, its administration and its environment in the university.

And now, against this background of the nature of engineering and the training of engineers, let us cast a picture of some major features of the American program for social progress. America needs work for some millions of unemployed. She craves protection against the perils of nature, such as floods and earthquakes and droughts, and against the man-made perils of transportation, fire and group violence. Wisdom urges her to seek conservation of her natural resources of soil, minerals and power. She needs better housing for large groups of her population. She realizes the advantages which would derive from a more efficient system of distribution of her products to her consuming public. Her people are striving, sometimes with violence, for higher wages, shorter hours of labor and a generally higher standard of living.

These are the things which are the major goals of our federal administration and our local governments and which are at any rate the most vocalized aspirations of our people. And every one of these things not only involves engineering, but can only be achieved through engineering, by engineers! This is a striking fact, of large significance in determining what should be our attitude toward the engineer and his training.

To emphasize this point let me suggest that good laws, proper financial adjustments, brotherly love and justice can all facilitate the happy attainment of these goals which I have mentioned, and their opposites can wreck us, but without engineering they are practically without avail to achieve the goals. As to their achievement, one might almost paraphrase the Holy Writ and say that, without engineering, laws and financial schemes are as sounding brass or a tinkling cymbal. For all these goals require the creation of physical things for the accomplishment of definite purposes. Laws and finances may give the setting, but the actual creation is the job for the engineer.

If I am right in this analysis, which I will proceed

in a moment to defend, is there not lacking a sense of proportion and fundamental understanding in some of the efforts which are being so feverishly exerted by our national leaders in their campaign to raise standards of living through such devices as distribution of wealth, creation of artificial employment, regulation of wages and hours of labor or curtailment of production—while practically neglecting effective methods of stimulating science and engineering to lay a solid basis for future progress?

Now let us turn more specifically to those major features of the American program which I listed a moment ago. The first was:

Reduction of Unemployment

Far and away the greatest task which has faced the American people in the last four years has been to take care of the great group of unemployed which appeared with the depression in numbers two or three times as great as the normal unemployable population. There can be nothing but praise for the promptness and boldness with which this emergency was tackled by the Federal Administration, whatever may have been the faults typical and perhaps unavoidable in so great and so sudden an enterprise. With this program of providing emergency work and providing outright relief when necessary, we have come through to better times. The basic problem, however, is far from solved, for unemployment still stands at figures nearly double the estimated unemployable population. Perhaps our greatest national problem is still that of handling this unemployed population. We could cheerfully support almost any emergency measures if we could see that they were leading us toward a permanent solution. What is the permanent solution?

There have been several schools of thought in this question, falling between the extremes illustrated by two incidents. One portrays the share-the-work movement reduced to an absurd extreme. The other presents the extreme claim of those who foresee the solution in the creation of new industries, by engineering science.

In the early days of the depression in one of the western states, the legislature had voted an appropriation for road building to provide employment. During the discussion, one legislator moved an amendment to the effect that no labor-saving machinery of any sort should be used in the construction, so that the maximum number of people might be employed. One of his colleagues then jumped up to amend the amendment, to specify that the workmen should be equipped only with teaspoons, in order that the maximum number of them might be required to perform the job. Without any further argument, I think, we can assert that this idea of dividing the work, while it may be advantageously employed up to a certain point in some situations, does not hold the key to an ideal solution of the unemployment problem. It is essentially unconstructive and represents a move backward in man's development as a creative being.

The other extreme was typified in 1934 by a joint symposium of the American Institute of Physics and the New York Electrical Society on the subject, "Science Makes Jobs." Here the speakers, of whom I was one, drew a vivid picture of the tremendous employment which has been made available through the development of the telephone, the automobile, the electrical and the chemical industries, all products of science and invention within the last generation or two and now affording not only luxuries and new necessities of life but also affording a livelihood to a very substantial portion of our total population. One of the speakers quoted Dr. Kettering's remark that the "trouble with us was not the over-production of goods but the underproduction of new ideas." The audience was asked to consider how much earlier and more severely the unemployment problem would have struck the country if even one or two only of these great technological industries had not been developed some decades ago. From this the inference was drawn that the most positive direction in which to seek jobs for the future is through the science and invention which join in productive engineering.

Of course the argument is not quite as simple as this last statement would imply. For example, if the automobile industry, together with the subsidiary business like sales, service, and oil, did not now provide employment for some three millions of our population, it does not follow that these three million people would now be unemployed. Some of them would never have been born, because their parents would have been too poor to raise more children. Some of them would have died in childhood, because the community could not have afforded the present standards of sanitation and medical care. Certainly many of them would be unemployed, and all the rest would be competing for work in the remaining industries—holding down the wage scale and all struggling for meager existence. I think we can certainly say that had the automobile industry not developed there would have been much more unemployment than there is now; there would have been far more misery, and the general standard of living would have been lower. Thus the automobile industry and every new creative industry is a boon to labor, to the consumer, and in fact to all the public.

Out of all the thought and discussion which have centered around the problem of unemployment this year, it seems to me that two features typified by the two examples just mentioned stand out rather clearly. One is that we have a responsibility to share the work

which is available to as great an extent as this may be consistent with good production and general economy. I shall have more to say about this point when we come to the subject of higher wages and shorter hours. The other feature is that the positive constructive cure for unemployment is to provide more really useful employment, which means to provide more things which people want and are willing to pay and to work for. Again we see that the constructive solution of the unemployment problem falls within the scope of engineering work.

When we consider the relatively small attention which has been paid to this constructive side of the problem of unemployment in the midst of the recent tremendous efforts to provide temporary relief, and to "prime the pump," I think we have food for some very serious thought. It does no good to "prime the pump" unless the well has been driven down to the ground water level; otherwise no water is pumped except what was poured in for priming. Similarly, unless the basis of emergency work reaches down to the creation and production of new things which people will work and pay for to possess, the emergency work is of little more value than a "setting-up" exercise. It is not only true that our policies have not devoted much attention to this basic and forward-looking problem of stimulating new industries for the future, but it is unfortunately true that there has been much, either directly or secondarily, in policies which have recently been put into effect for other purposes, which acts as a definite deterrent or penalty to constructive steps toward new industries and employment by private agencies. In other words the government has been relatively inactive and at the same time has permitted tax and code legislation which definitely inhibit action by private agencies in the directions which would bring ultimate employment.

However these things may be, one thing, I believe, is clear, and this is the main feature of my argument. It is that the engineer has a key position in the solution of the unemployment problem.

PROTECTION AGAINST PERILS

The second major feature of our American program is protection against both natural and man-made perils. Scarcely a year passes without some major catastrophe which takes the lives of hundreds, causes suffering and hardship to thousands and destroys millions of dollars worth of property. Within the past month we have had the greatest flood in the history of the Ohio River. Last year came great floods in New England. Two and three years ago drought and the dust storms devastated the great plains of the West. Earthquakes have done great damage in California on a few occasions, and cause the inhabitants continual uneasiness.

When we come to protection against man-made hazards, we have continually brought to mind the safety of the highways and of airplanes through almost daily news of fresh disasters; and on the larger scale we have the problem of national defense.

The significant thing about every one of these items of protection of large groups of people against peril and hazard is that each one is primarily the job of the engineer. It was the army engineers who directed and carried out the safety measures in the recent flood of the Ohio and Mississippi Rivers and under whose jurisdiction rests control of the waters of all navigable streams. It was Arthur Morgan as an engineer who directed the fine project of flood control in the dangerous Miami River Valley in such fashion that this region has never again been in serious danger. It will be engineers who will do what can be done for protection against drought on the great plains through water storage projects and measures for impounding water in the soil. The problem of highway safety is primarily one for engineers, both in the design of highways and in the design for automobiles. Safety in the air, while still carrying a large element of the human equation, is nevertheless ultimately a problem for the engineer to design planes of such stability and to steer them to their destination with such certainty and to construct them with such durability that they are dependable as machines and make safety largely automatic in the hands of the pilot. In our national defense the construction and operation of ships is an engineering job of the highest caliber, and the predominating engineering work of the army is shown by the fact that the United States Military Academy was founded as an engineering school and so continues.

One aspect of the engineer's work in protecting the public from hazards is illustrated in such elements as fire and earthquakes, for not only have the engineers designed fireproof structures, fire-extinguishing devices, fire alarms and fire-fighting equipment and have designed earthquake-proof buildings, but they have been largely responsible for the organization of the extensive system of fire, earthquake and similar insurance. This is a doubly advantageous arrangement, for not only does their training enable them to properly estimate the risks, but their training and self-interest both cause them to take the lead in devising ways and means to reduce the risks. The prominence of engineers in this field is illustrated by the fact that nineteen out of the twenty-three presidents of the Associated Mutual Factory Fire Insurance Companies are graduates of one signal engineering school, and for all I know the other four may also be engineer-trained.

If we consider the less spectacular but no less real danger which lurks in an impure water supply or a mosquito-infested swamp or a polluted stream, again we find that it is the engineer who is protecting the public from danger.

(To be concluded)

OBITUARY

FREDERICK VERNON COVILLE

DR. FREDERICK V. COVILLE, principal botanist in the U. S. Department of Agriculture, honorary curator of the U. S. National Herbarium under the Smithsonian Institution, and acting director of the National Arboretum, died at his home in Washington, D. C., on January 9, of coronary thrombosis sustained a week earlier. He was born in Preston, N. Y., on March 23, 1867, and was married in 1890 to Miss Elizabeth Harwood Boynton, who with three sons and one daughter survives him. He is best known for his achievements in botanical and agricultural research, but his interests were many and his contributions in widely different fields, particularly that of public welfare, were noteworthy.

After graduation at Cornell University (A.B., 1887), Dr. Coville taught there a short time, served as botanical assistant on the Arkansas Geological Survey, and in July, 1888, was appointed assistant botanist in the Department of Agriculture. In 1893 he succeeded Dr. George Vasey as botanist and as curator of the National Herbarium, then in the custody of that department. Upon the reorganization of scientific work within the Department of Agriculture in 1901 he was placed in charge of botanical investigation and experiment in the newly created Bureau of Plant Industry and, under varying titles, continued in that capacity during the remainder of his life.

Dr. Coville's most important field work was that as botanist of the famous Death Valley Expedition in 1891, the results of which were published two years later as "Botany of the Death Valley Expedition." This volume, one of the earliest critical studies of desert vegetation, is classic. It is a characteristically thorough piece of work, composed in the simple lucid style that distinguished all his writing, and aside from its precise identification of species is notable for the introductory chapters on ecological plant geography, based on personal observation and study, which present a searching analysis of the climatic and edaphic features of the region in their relation to its vegetation. Dr. Coville's keen interest in desert plants never waned. Later, as adviser to the Carnegie Institution of Washington, he procured the foundation of the Desert Botanical Laboratory near Tucson, Ariz., and at the time of his death was engaged in writing a popular but detailed flora of Death Valley, which should take account of much new material, including specimens collected by himself on three recent trips (1931–32).

In purely taxonomic work Dr. Coville devoted himself especially to the rushes (Juncaceae), in which he was long the acknowledged American authority, and to our native currants and gooseberries (Grossulariaceae), of which, jointly with Dr. N. L. Britton, he published a systematic treatment in "North American Flora." Many papers in his list of nearly 175 titles include descriptions of new species in other families, as well as discussions of nomenclature and matters of bibliography; others trace in detail the routes of early botanical exploration in the West; still others relate to ethnology and to the plants used by the American aborigines; and more than a few, based on personal studies in the western United States, deal with practical problems of grazing and forestry. Assisted by Mr. W. F. Wight and others he prepared the botanical definitions for the revised edition of the Century Dictionary. The final establishment of a National Arboretum was due largely to his perseverance and his unflagging devotion to the project. For many years also he served as chairman of the Research Committee of the National Geographic Society and thus was influential in determining its policy of exploration.

On the score of public service there may here be quoted an expression of opinion received from Gifford Pinchot, first forester of the United States:

> Until the Forest Service developed a body of experts of its own, Frederick V. Coville was the first and the earliest authority on the effect of grazing on the forest.
>
> In February, 1898, the old Division of Forestry published a bold and masterly discussion by Dr. Coville on forest growth and sheep-grazing in the Cascade Mountains of Oregon, which went straight to the root of a very bitter controversy. In this study Dr. Coville laid down the essentials of a sound and far-sighted grazing policy.
>
> When a vital issue arose, in 1902, between the irrigation farmers of the Salt River Valley in Arizona and the woolgrowers who ran their sheep on the irrigators' watershed, Dr. Coville's unequalled experience of grazing and plant life was called in. He and I made an extensive study on the ground, accompanied by representatives of the contending sides, and settled that and other questions. Our report rested on Dr. Coville's profound field knowledge of his subject, indefatigable thoroughness, and conspicuous fairness and common sense. He was already my friend, but that trip laid more deeply the foundations of a friendship which lasted throughout his life.
>
> In 1905 the Public Lands Commission published Dr. Coville's proposals for the regulation of grazing on the public lands. Then and later his advice was in demand. His part in formulating a national grazing policy was that

of the pioneer. If Dr. Coville's advice had been taken, the West would have escaped vast losses which have since fallen upon it.

From 1910 onward, however, experiments in blueberry culture took precedence of his other interests, and it was this investigation in cultivating, hybridizing and selecting improved strains of the blueberry plant that gave full play to Dr. Coville's special abilities—his keenness of observation and fine technique of workmanship, and an almost infinite patience in following out details. Many collateral problems had also to be solved—in particular, the effect of soil acidity upon plant growth and the stimulating rôle of cold—with the final result that large-fruited "domesticated" blueberries, in many fine varieties, are now securely established as a profitable commercial crop in the acid sandy soils of our eastern coastal plain. Largely through his work and writing the artificial acidulation of soils and the basic requirements in the culture of acid soil plants are matters of general knowledge at present.

Notwithstanding this record of accomplishment, Dr. Coville's time seemed never his own. Of unusually broad interests and possessed of sound judgment in practical matters, he was constantly besought for advice upon all sorts of questions and projects by many who knew his never-failing spirit of helpfulness. His friendly cooperation was proverbial; equally his comment, based on quick perceptions and a wide experience, was penetrating and apposite. As the necessary starting-point and background for economic work with plants he always emphasized the importance of sound taxonomic studies. Himself a clear thinker, he was imbued with almost a passion for accuracy and precision. Thus his influence over a long period of years was uncommonly helpful and inspiring to younger men within the department and it was effective also in a far wider scientific and educational field, where it will be sorely missed. He will long be missed also in other walks of life, for he had in high degree that quick unaffected and sympathetic interest in people that is the genius for friendship.

Erect and well over six feet in height, Dr. Coville was of distinguished bearing; in college he had been an outstanding athlete. He was conservative and of great natural dignity; but coupled with this there were boyish enthusiasms that had to be shared with his friends, and those who had the privilege of out-of-door association with him will cherish their recollections of his comradeship. A field trip, even a walk through familiar woods, took on new possibilities of enjoyment from his awareness of the surroundings and his keen interest in every living thing therein, and was bound to yield new information or help to satisfy some question to which his inquisitive spirit seemed always to lead. He had moreover a profound appreciation of beauty in nature—a depth of feeling that often enough is smothered by matter-of-fact scientific accomplishment. His mind was stored with a lifetime's recollections of field incidents, of plants in a particular setting, and of other natural phenomena, and on occasion these memories would be brought forth as vividly as if the happenings or scenes were of yesterday, and, one may add, with astonishing detail as to essentials. Out of an active mind so equipped, trained and stored, the new "Death Valley Flora" would have been a fitting sequel to his earliest and most important botanical work. That he could not complete this upon retirement from government service, which would have followed shortly, will be a matter of general regret. But to those who knew Dr. Coville well a sense of personal loss will prevail, in the passing of a friend in whom steadfast loyalty and consideration were never wanting.

WILLIAM R. MAXON
SMITHSONIAN INSTITUTION

RECENT DEATHS AND MEMORIALS

DR. ELIHU THOMSON, of the Thomson-Houston and General Electric Companies, director of the Thomson Research Laboratory at Lynn, Mass., died on March 13 at the age of eighty-three years.

DR. WILLIAM HARDING LONGLEY, professor of biology at Goucher College since 1919, in administrative charge of the Marine Laboratory in Tortugas of the Carnegie Institution of Washington, died on March 10 at the age of fifty-six years.

DR. RANDOLPH WINSLOW, emeritus professor of surgery at the school of medicine of the University of Maryland, died on February 27 at the age of eighty-four years.

DR. ARTHUR RUDOLPH MANDEL, professor of clinical pathology at New York University Medical School, died suddenly on March 7. He was fifty-nine years old.

DR. ALFRED DOUGLAS FLINN, since 1922 director of the Engineering Foundation, formerly deputy chief engineer of the Board of Water Supply of the City of New York, died on March 14 at the age of sixty-seven years.

WILLIAM TAYLOR, inventor and maker of improvements in scientific apparatus, especially lenses, governing director of Taylor, Taylor and Hobson's, Leicester, England, died on February 28 in his seventy-second year. He was elected a fellow of the Royal Society in 1934, and was a member of the Council of the National Physical Laboratory and past president of the Institution of Mechanical Engineers.

Nature states that to commemorate the services of

the late Sir Grafton Elliot Smith to University College, London, and to the advancement of anatomical and anthropological teaching and research, it is proposed that a bust of him should be modeled in bronze by A. H. Gerrard, of the Slade School, and placed in the Thane Library of the college. Contributions towards the cost of the bust, made payable to "The Elliot Smith Memorial Fund," should be sent to Professor J. P. Hill, University College, Gower Street, London, W.C.1.

SCIENTIFIC EVENTS

JOINT MEETING ON AGRICULTURAL PROCESSING

THE American Society of Agricultural Engineers and the Process Industries Division of the American Society of Mechanical Engineers and Farm Chemurgic Council held a one-day meeting on agricultural processing, at Rutgers University, on February 26.

This meeting was planned to bring together the chemists and physicists who originate processes of making new useful products from various farm-grown materials; the processing engineers who develop and apply the processes on a commercial scale, and the agricultural engineers who are interested in enabling farmers to deliver the basic materials to processing plants within the required limits as to cost, physical condition and time and quantity of delivery.

L. F. Livingston, past-president of the American Society of Agricultural Engineers and manager of the agricultural extension section of the E. I. du Pont de Nemours and Company presided at the morning session which opened at 10 o'clock. Papers read at this session included "Processing Research in Agriculture," by John F. Ferris, acting director of the agricultural industries division of TVA; and "Hemp and Flax from the Seed to the Loom," by George A. Lowry, of Lowry and Grant.

A "research luncheon" was held at the Elks Building at 1:00 P. M. Dr. W. H. Martin, director of research at Rutgers University, addressed the group on "Agricultural Research Work," and Dr. Paul L. Hoover, director of the New Jersey Engineering Experiment Station, spoke on "Engineering Research."

Victor Wichum, chairman of the Process Industries Division of the American Society of Mechanical Engineers, presided at the afternoon session. In the afternoon Mr. Livingston gave an address on "Processing Engineering in Agriculture." He was followed by C. E. Thomas and A. Weisselberg, of the drying committee of the Process Industries Division, with a paper on "Drying of Agricultural Products—The Technical and Economical Aspects."

R. C. H. Heck, of the department of mechanical engineering, and E. R. Gross, head of the department of agricultural engineering, Rutgers University, were in charge of local arrangements for the meeting.

COSMIC RAY RECORDING STATION IN MEXICO

DR. ARTHUR H. COMPTON, of the University of Chicago, accompanied by Professor M. S. Vallarta, of the Massachusetts Institute of Technology, established during his recent visit to Mexico a permanent cosmic ray recording station, the fifth of the series that he is using for the measurement of the rays. Dr. Joaquin Gallo, director of the Mexican National Magnetic Observatory, and Dr. Mongez Lopez, director of the study of physical sciences of the National University of Mexico, of which the observatory is a part, are cooperating in the work.

The cosmic ray observatory is a small frame building erected on the grounds of the National Magnetic Observatory at Teolyucan, thirty miles north of Mexico City at an altitude of about 7,500 feet in a region far from any high mountains or buildings. The building is constructed with good thermal insulation so that both the diurnal and annual temperature variations are very small, amounting to a maximum of about 5° C.

The cosmic ray meter is one of the "Model C" meters of the type prepared for the Carnegie Institution of Washington. Its ionization chamber consists of a 20-liter steel sphere filled with argon at 40 atmospheres. The ionization by the cosmic rays is normally balanced by that due to the beta rays from a uranium rod, which enter an auxiliary chamber. This balance is unaffected by changes in temperature or pressure of the gas. The sensitivity is so adjusted that the maximum changes in the cosmic rays give variations in the reading of the meter which remain on the scale of the instrument. The records are made continuously on photographic paper and are being analyzed at Chicago.

A feature in connection with the operation of an observatory at this site is that because of the high altitude the cosmic ray bursts are more frequent than at sea level. For this reason the variations in the cosmic rays are greater and the sensitivity at which the meter operates must be lowered in order that the deflections of the meter shall remain on the scale. The immediate program is one of study of the diurnal and seasonal variations over a period of eighteen months. It is hoped, however, to continue the records for a longer time.

Permanent cosmic ray meters have been installed in Chicago, Washington, D. C., at Huancayo, Panama, and at Christ Church, New Zealand. Another meter has been installed on the *S. S. Orangi,* a steamship which plys the route from Vancouver to Australia. On each voyage, the meter readings give the difference in incidence of rays between the northern and southern hemispheres. The Chicago station is to be placed on Mt. Evans, Colorado, and another, temporarily located at the Massachusetts Institute of Technology, will be shifted to Greenland. There are only two other stations, those of Hess and Schonland, both of these having been made by E. Steinke, the German physicist.

SCIENTIFIC MEETINGS AT LANCASTER, PENNSYLVANIA

THE Pennsylvania Academy of Science, the Junior Academy, the Pennsylvania Conference of Teachers of College Physics and the Lancaster Branch of the American Association for the Advancement of Science will hold a joint session at the time of the annual meeting of the academy at Lancaster on March 26 and 27. The Lancaster Branch and Franklin and Marshall College are to be hosts. All scientific activities will be held on the college campus. Friday morning and afternoon, March 26, will be devoted to general sessions divided into subject groups, physics, biology, miscellaneous papers and the Junior Academy. Exhibits will supplement the sessions. The annual dinner has been scheduled for Friday evening at the Hotel Brunswick. This is to be followed by an address by Dr. F. R. Moulton, distinguished for his work in mathematics and astronomy, permanent secretary-elect of the American Association for the Advancement of Science. Dr. Moulton will speak on "Science."

Saturday's session is to commence with a brief business meeting at nine in the morning, followed by short invited papers as follows: "The Birds of Lake Ontelaunee, Berks County," Earl L. Poole, Reading Public Museum; "The Status of the Upland Plover in Pennsylvania," Professor Herbert H. Beck, Franklin and Marshall College; "Reminiscences of Professor William S. Franklin," Professor R. L. Charles, Franklin and Marshall College; "Effects of Pressure and Temperature on the Germination of Seeds," Dr. R. B. Dow and Dr. Rafael Rivera, Pennsylvania State College; "Measuring Gravity at Sea," Professor Maurice Ewing, Lehigh University; "The Origin and Occurrence of Earthquakes," Professor H. Landsberg, Pennsylvania State College; "Some Biological Effects of Sounds of High Intensity," Dr. L. A. Chambers, Johnson Foundation for Medical Physics, University of Pennsylvania.

The sessions will conclude at noon on Saturday. Buffet lunches are to be served at the college. Those planning to stay over night are requested to make their own hotel reservations. Inquiries may be addressed to Professor Wheeler P. Davey, State College, Pa., representing the Conference of Teachers of College Physics; Dr. V. Earl Light, Lebanon Valley College, Annville, Pa., secretary of the Pennsylvania Academy of Science; Dr. Karl F. Oerlein, State Teachers College, Indiana, Pa., representing the Pennsylvania Junior Academy of Science, or Jaques Cattell, Science Press, Lancaster, Pa., representing the Lancaster Branch, American Association for the Advancement of Science.

THE NORTH CAROLINA MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE ninety-third meeting of the American Chemical Society will open for a four-day session at the University of North Carolina on April 12. Fifteen divisions of the society will conduct symposia in various fields of research and a group of foreign scientific men will report on their work.

On Monday, April 12, the meeting will be opened by Dr. E. R. Weidlein, director of the Mellon Institute of Industrial Research in Pittsburgh, president of the society. Among those who will give addresses on the first day of the meeting will be Dr. Robert R. Williams, chief chemist of the Bell Telephone Company Laboratories in New York and a research associate at Columbia University, whose discovery of the chemical structure of vitamin B led to synthesis of the vitamin.

Dr. Williams's work and subsequent experiments made possible by them will play an important part in a symposium on Vitamin B, which will be held on the second day of the meeting, in which the Divisions of Agricultural and Food Chemistry, Biological Chemistry and Medicinal Chemistry will cooperate. On the following day these same divisions will work together in a symposium on other vitamins.

Cellulose chemistry, synthetic plastics and the chemistry of solid surfaces will be discussed in other symposia to be given in division meetings. The Cellulose Division will devote Tuesday to a general symposium on cellulose developments, and on Wednesday will hold two sessions for the presentation of general papers. On Wednesday morning the Division of Paint and Varnish Chemistry, under the chairmanship of Dr. Gordon M. Kline, will hold a plastics symposium, and the Division of Physical and Inorganic Chemistry will report work in the chemistry of solid surfaces.

Studies of sugars, starches and related products, including a report on the bacteriological analysis of more than 1,000 different sugars, will be taken up at the meetings of the sugar division. The division of microchemistry will present papers on the stability of cellulose nitrates and other explosives, and reports on the latest advances in the design of laboratories and equipment.

Papers on high-speed vulcanizing to step up the production rate of rubber-insulated wire, tests of the efficiency of various types of rubber as vibration absorbers and a new type of hammer test for the elasticity of soft rubbers will be presented to the Rubber Division. The behavior of emulsions and the surface tensions of various liquids and their effect on each other will be among the subjects taken up at the meetings of the colloid division.

Other fields to be covered in divisional sessions through symposia and general papers are chemical education, gas and fuel developments, industrial and engineering progress, organic chemistry and water, sewage and sanitation chemistry.

Dr. Frank K. Cameron, professor of chemistry at the University of North Carolina, has been designated honorary chairman of a local committee to make arrangements for the convention. The general chairman is R. M. Grumman, of the university, and E. C. Markham will act as secretary-treasurer. Other committee members are: Housing, J. S. Bennett; meeting rooms, H. D. Crockford; registration and information, G. M. Hill; group dinners and luncheons, Haywood Duke; transportation, Herman Schnell; entertainment, Harry Comer; plant visits and sightseeing trips, J. Maryon Saunders; publicity, R. W. Madry; golf and tennis, R. B. Lawson; safety, P. L. Burch; women's activities, Mrs. Edward Mack, Jr.; women chemists, Miss Frances Brown.

THE JOHN SCOTT AWARDS

As has been already recorded in SCIENCE, Dr. W. D. Coolidge and Dr. Irving Langmuir, director and associate director, respectively, of the Research Laboratory of the General Electric Company in Schenectady, and Dr. Evarts A. Graham, of the School of Medicine of Washington University in St. Louis, were recipients of the John Scott 1937 awards granted by the City Trusts of the City of Philadelphia at a dinner of the American Philosophical Society on March 5. With each award went a certificate, a copper medal and $1,000 in cash.

The award to Dr. Coolidge was based on his application of a new principle in x-ray tubes; to Dr. Langmuir for his physical and chemical discoveries resulting in improved gas-filled incandescent lamps, and to Dr. Graham for his application of the x-ray to the study and diagnosis of gall bladder conditions.

In making the presentations, Ernest T. Trigg, chairman of the Board of City Trusts, explained that history had made but scant recordings of John Scott, the donor of the fund, and his reason for bequeathing to the City of Philadelphia in 1816 the sum of $4,000, the income from which was to be "laid ont in premiums to be distributed among ingenious men and women who make useful inventions." It was originally stipulated that no award was to carry a cash premium of more than $20 and the medal was to be inscribed "To the most deserving."

John Scott was a chemist in Edinburgh, Scotland, and why he chose Philadelphia for his grant is a mystery. It is thought his attention had been drawn to the city either through the American Philosophical Society or his admiration of Benjamin Franklin, whom he may have met when Franklin visited Scotland in 1769. When the fund was taken over by the newly created Board of City Trusts, the principal had grown to $21,000, and in 1917, or 100 years after the original grant, it amounted to $100,000. At this time the board appealed to the courts and received permission to increase the amount of the awards to a maximum value of $2,000, but none has been for any amount greater than $1,000.

In the period between 1920 and 1937, inclusive, 73 awards have been made to scientific men and inventors in all parts of the world, including Japan, Holland, England, France, Italy and South America. Among the recipients have been Madame Curie, Reginald A. Fessenden, Orville Wright, Lee de Forest, Thomas A. Edison, Guglielmo Marconi, Samuel M. Vauclain, W. L. R. Emmet, Nikola Tesla, Charles F. Kettering and Edward G. Budd.

SCIENTIFIC NOTES AND NEWS

DR. SIMON FLEXNER, director emeritus of the Rockefeller Institute for Medical Research, New York, was elected a foreign associate of the Academy of Sciences, Institute of France, at a meeting held in Paris on February 22. He succeeds the late Emanuele Paterno, Marquis di Sessa, of Palermo, Sicily.

DR. CARL G. HARTMAN, of the department of embryology of the Carnegie Institution of Washington, has been elected to membership in the International Institute of Embryology at Utrecht.

DR. REUBEN L. KAHN, since 1928 director of laboratories, University Hospital, and assistant professor of bacteriology at the University of Michigan Medical School, was recently presented with a gold medal by the Phi Lambda Kappa fraternity for his research work in tissue immunity. The presentation took place at the annual meeting of the fraternity in Detroit.

THE 1936 Manly Memorial Medal recently awarded to Raymond W. Young, assistant engineer of the Wright Aeronautical Corporation, Paterson, N. J.,

for giving the best paper of the year on aeronautical science before the Society of Automotive Engineers, was presented to him on March 12 at a dinner at the Hotel Mayflower in Washington, D. C.

THE foreign secretary of the Physical Society, London, in notifying Dr. Walter G. Cady, Foss professor of physics at Wesleyan University, of the award to him of the Duddell Medal for 1936, wrote: "Your pioneer work has stimulated research work on the subject in all parts of the world and has found practical applications in the quartz clock, the measurement and control of the frequency of alternating currents, and the measurements of the velocity of ultrasonic waves."

THE Cameron Prize for 1937 has been awarded by the senatus of the University of Edinburgh to Dr. J. Bertram Collip, professor of biochemistry at McGill University, in recognition of his contributions to endocrine therapy and in particular of his work on the parathyroid gland.

AT the recent meeting of the New Orleans Academy of Science at Hammond, La., Dr. H. L. Kearney, of New Orleans, was elected president. Chairmen of the sections elected were: Dr. John R. Fowler, Louisiana Polytechnic Institute, biological science; Dr. R. L. Menville, Louisiana State University, applied science, and D. T. Tarlton, Louisiana Normal School, social sciences. E. A. Fieger, Louisana State University, was elected permanent secretary, and Dr. Irby C. Nichols, Louisiana State University, editor. The academy awarded a gold medal for the best paper to Dr. Charlotte H. Boatner, of H. Sophie Newcomb Memorial College, and the original research prize of $25 to I. M. Le Baron, graduate student of Louisiana State University.

AT the annual meeting of the Royal Astronomical Society the following officers were elected: *President*, Dr. H. Spencer Jones; *Vice-presidents*, Sir Frank Dyson, Professor E. A. Milne, Professor H. C. Plummer and Professor W. M. Smart; *Treasurer*, J. H. Reynolds; *Secretaries*, W. M. H. Greaves and Professor H. H. Plaskett; *Foreign Secretary*, Sir Arthur Eddington.

DR. WILLIAM HENRY WESTON, JR., chairman of the department of botany at Harvard University, has been appointed visiting professor of mycology at the Johns Hopkins University.

DR. S. J. SHAND, of the University of Stellenbosch, South Africa, has been appointed professor of geology at Columbia University. He will conduct the courses in petrology. He is expected to take up the work in New York in September.

DR. OSCAR W. RICHARDS has resigned from the department of zoology at Yale University to accept the post of research biologist with the Spencer Lens Company. Dr. Trenton K. Ruebush, of the University of Virginia, has been appointed to succeed him. Dr. Donald F. Poulson, of the Carnegie Laboratory of Embryology, has been appointed to an instructorship in the department of zoology at Yale University.

AN exchange arrangement has been made by which Dr. Daniel Buchanan, dean of the Faculty of Arts and Sciences at the University of British Columbia, will conduct courses in astronomy during the summer session at the University of California at Los Angeles and Dr. Frederick C. Leonard, chairman of the department of astronomy at Los Angeles, will lecture at the University of British Columbia.

PROFESSOR JOHN MCLEAN THOMPSON, director of the Hartley Botanical Laboratory and dean of the Graduate School of the University of Liverpool, will be in residence from June 15 to July 22 in the Summer School of Botany at the Iowa State College at Ames. He will give courses on the morphology of the reproductive organs and on the evolution of plants.

DR. H. P. NEWSHOLME, medical officer of health to the City of Birmingham, England, has been appointed professor of hygiene and public health at the University of Birmingham to succeed the late Sir John Robertson.

DR. CHARLES ROBBINS SCHROEDER, veterinarian and pathologist of the zoological park at San Diego, Calif., since 1932, has been appointed veterinarian of the New York Zoological Park, the Bronx, to succeed Dr. Charles V. Noback, who died on January 16.

F. A. LOPEZ DOMINGUEZ, director of the Puerto Rico Agricultural Experiment Station, has been given leave of absence for a year to aid in the work of the Puerto Rico Rehabilitation Administration. Dr. Melville T. Cook has been appointed acting director of the station during his absence.

DR. SAÏM SAĞLIK, of the Gulhane Post-Graduate Medical School of Istanbul, and Dr. Elemér Scipiades, of Pécs and Budapest, are working on problems relating to reproduction at the department of embryology of the Carnegie Institution of Washington.

SIR ALDO CASTELLANI, surgeon-in-chief for the Italian army in Ethiopia, returned to New Orleans on March 5 to give a course of lectures in connection with his work as professor of tropical medicine at the Medical Center of the Louisiana State University.

DR. THOMAS J. HILL, professor of clinical oral pathology and therapeutics of the School of Dentistry of Western Reserve University, and Dr. Morris Steggerda, of the Carnegie Institution, Washington, D. C.,

have left for Chichen Itza, Yucatan, to make a study of dental caries among the Mayan Indians.

DR. COLIN G. FINK, professor of electrochemistry at Columbia University, addressed the members of the Royal Canadian Institute at Toronto on February 27 on "Products of Electrochemistry," referring in particular to his own researches.

THE seventh Joseph Henry lecture was delivered by Dr. James Franck, professor of physics at the Johns Hopkins University, before the Philosophical Society of Washington on March 13. He spoke on the "Fundamentals of Photosynthesis."

DR. ARTHUR HAAS, formerly of the University of Vienna and at present of the University of Notre Dame, addressed an open meeting of the Purdue University Chapter of Sigma Pi Sigma, physics honor society, on February 25. He spoke on "The Fundamental Principles Underlying Modern Physics."

DR. ROBERT B. SOSMAN, of the Research Laboratory of the United States Steel Corporation, will give the annual Edward Orton, Jr., memorial lecture sponsored by the fellows of the American Ceramic Society, at the annual meeting in New York on March 23. The subject will be "Pyrometry and the Steel-maker's Refractories."

DR. LUDVIG HEKTOEN will deliver the first Christian Fenger Lecture of the Institute of Medicine of Chicago and of the Chicago Pathological Society at a joint meeting with the Society of Medical History of Chicago and the Chicago Surgical Society on the evening of March 26. His subject will be "Early Pathology in Chicago and Christian Fenger."

THE annual lecture of the James A. Gibson Anatomical Society at the University of Buffalo School of Medicine will be given on Tuesday evening, March 23, by Dr. S. W. Ranson, of Northwestern University. Dr. Ranson will speak on "The Hypothalamus." The Gibson Anatomical Society is an organization of students in the School of Medicine who have done superior work in the courses in anatomy.

A ROUND table discussion of "Capillaries" will be held at the meeting of the American Association of Anatomists in Toronto from March 25 to 27. Drs. Richard G. Abell, Robert Chambers, Eliot R. Clark, Eleanor L. Clark, James B. Rogers and B. W. Zweifach will contribute papers. The discussion will probably be led by Dr. R. R. Bensley and Dr. W. B. Cannon. Dr. E. V. Cowdry will preside.

DR. J. HOWARD MATHEWS, chairman of the department of chemistry at the University of Wisconsin, is making a lecture tour through the South and Southeast. The trip is sponsored by the American Chemical Society. The lectures which are given under the auspices of local sections of the society are entitled "Use of Scientific Methods in the Identification of the Criminal." They are illustrated by lantern slides and examples of the applications of the various techniques taken largely from the personal experience of the lecturer.

THE twenty-seventh series of the Hepsa Ely Silliman lectures will be delivered in April at Yale University by Dr. David M. S. Watson, Jodrell professor of zoology and comparative anatomy at University College, London. The subject of the lectures will be "Paleontology and Modern Biology," and they will deal principally with the character of the evolutionary process as illustrated by the study of the fossil vertebrates. The lectures will be eight in number and will be given in Strathcona Hall at 4:15 P.M., on alternate days of the week, beginning on April 12 and ending on April 28.

THE annual joint meeting of the Institute of Radio Engineers and the American Section of the International Scientific Radio Union will be held in Washington, D. C., on April 30. Papers on the more fundamental and scientific aspects of radio will be presented. There will be two sessions at the building of the National Academy of Sciences, 2101 Constitution Avenue, Washington, D. C., beginning at 10 A. M. and 2 P. M. Papers will be limited to fifteen minutes each to allow time for discussion.

THE ninth anthropological and archeological Smithsonian expedition to Alaska, under the leadership of Dr. Aleš Hrdlička, will leave Seattle on May 20. The object of this year's expedition will be as far as possible a thorough reconnaissance of pre-Russian village sites and burial caves on the Gulf coasts, on the Peninsula and especially in the Aleutian chain, with possibly a visit to the Commander Islands. As in the past, Dr. Hrdlička will take along a small number of volunteer students, who with him will carry on the work. In return they get such field instructions as may be possible and a course of lectures on the principles of anthropology and American archeology. The number of those that can be taken along must this year be limited to five because of difficulties of transportation. The applicants must be strong, healthy young men and earnest students. They pay their personal expenses, but these will be very moderate. Otherwise there are no charges. Recommendations by two professors will be required of each applicant. For further information write to Dr. A. Hrdlička, U. S. National Museum, Washington, D. C.

THE hundred and fifth annual meeting of the British Medical Association will open in Belfast on July 16

under the presidency of Professor R. J. Johnstone, professor of gynecology in Queen's University.

THE Oberly Memorial Prize will be awarded this year in the sum of $100 for the best bibliography submitted in the field of agriculture and related sciences. Four copies of each bibliography entered should, before March 31, be in the hands of the chairman of the Oberly Memorial Fund Committee, Gilbert H. Doane, director of University Libraries at the University of Wisconsin.

Industrial and Engineering Chemistry reports that the president of the American Welding Society has announced acceptance by the Board of Directors of a gold medal to be known as the Lincoln Gold Medal and to be presented to the author of the best paper on any phase of welding published in the *Journal of the American Welding Society* during the year October, 1936, to October, 1937. The donor of the medal is J. F. Lincoln, president of the Lincoln Electric Company, who makes this contribution as a stimulus to the preparation of worth-while contributions on the art of welding. Further information can be obtained from the society at 33 West 39th Street, New York N. Y.

THE Secretary of State for Scotland announces that the office of regius professor of chemistry in the University of Glasgow will become vacant on October 1, 1937, owing to the resignation of Professor G. G. Henderson, and that it is proposed to take steps with a view to the filling of the vacancy. Applications, accompanied by two copies of recent testimonials, should be addressed to the Private Secretary, Scottish Office, Whitehall, London, S.W.1, and should reach him not later than April 30.

PLANS are being prepared for an entire new group of buildings for the College of Engineering at Cornell University. The trustees have appropriated $5,000 for this purpose and have designated R. Harold Shreve, '02, of Shreve, Lamb, and Harmon, New York City, as architect. A detailed study of the present status and future needs of the college has been under way for some time and will be continued.

Industrial and Engineering Chemistry reports that the Bausch and Lomb Optical Company has opened a new laboratory for applied research in order to enter upon a broad program of fundamental investigations on the chemistry and physics of glass surfaces and on the development of new materials and processes for the industry. Frank P. Kolb is chief chemist, and Theodore J. Zak, assistant chemist. A series of laboratory units are devoted to research in the fields of metallurgy, experimental electroplating, spectroscopy, photomicrography and physical testing. One of the most interesting units is that in which James E. Wilson and his assistant, Vernon Patterson, are engaged in applying metallurgical equipment to the study of the structure of the steels and alloys used in industry. The testing and control laboratory, directed by Ray A. Kirchmaier and Joseph T. Anderson, is equipped for general analytical work. D. M. Webb has been added to the staff for research in chemistry, one of his immediate problems being the electrodeposition of various metallic substances as a backing for reflectors.

DISCUSSION

FOSSIL CYCAD NATIONAL MONUMENT

WHAT this monument (as set aside by act of Congress in 1922) means in the series of national monuments and to botanical science needs to be simply told, though clearly the remarkable flowering cycadeoids which give the monument its feature can never be fully told about in words alone. They need *in situ* exhibition. That's the reason for the monument. Thus far the great collections from the monument have received much attention in many and sumptuously illustrated scientific contributions. The more primary scientific values involved have had wide notice the world over in both paleontologic and botanic texts. Yet that splendid landscape so replete with geographic and evolutionary values has had but meager illustration. Moreover, exactly within the past ten years six distinct lines of study and research have greatly enhanced the monument values.

Firstly, the cycadeoids of the Beskids of the Carpathians have been given that exacter illustration which shows them to be related to some of the Black Hills types, close as are perhaps European to American oaks, the same being true of the cycadeoids of the Apennines, the Isle of Wight and the Isle of Portland. That is, we have here to deal with types of uncommon beauty and very wide distribution in both latitude and time. If the display at the monument is brought into and rigidly kept in a real unity it will always have a deep interest to the foreign visitor.

Secondly, there is now in view a fine addition of types from the Trinity Beds of Texas, as noted in SCIENCE. These are conveniently grouped as five new species, but so closely resemble the several Black Hills types as to suggest a mere southern outlier of the monument forest.

Thirdly, while the geologic age of the monument

types is Lakotan or very low Cretaceous, if not Jurassic, high up in the Upper Cretaceous or Mesaverde of New Mexico and Arizona there are now found to occur in a striking alignment three species of those free-flowering relatives with fruiting in all the frond base axillae. Such types have been for some time known to be of wide distribution ranging back to the close of the Jura, though hitherto exceedingly rare in collections. While closely related to Cycadeoidea, the free-flowering species (eight in all) are now set in a new genus *Monanthesia,* as named from the strong tendency to monocarpy or a single season flowering or anthesis. The Mesaverde species are *Monanthesia magnifica, M. blanca* and *M. equalis,* as already illustrated. That this general type extends back into the Jura and may be old is highly significant. The finest representative thus far discovered is the *Monanthesia* (Cycadeoidea) *Dartoni* from the Como or closing Jura of the Black Hills, taken as an equivalent of the Wealden of the Isle of Wight. This is not only one of the most remarkable of all ancient completely petrified plants, but one of the most elaborately studied and illustrated.

Fourthly, renewed attention to the petrified stems from the Isle of Portland shows them to be far more instructive than appeared during all early cutting as done without the aid of etching over larger surfaces. Of singular interest is what may be seen in the complete tangent armor sections of the *Cycadeoidea microphylla* of Buckland. From these sections it is found that what looks like a heavy globular to flat stem is merely a lesser, even slender stem bearing a mass of large bract-enveloped branches. The initial foliage fronds are few and small or little above scale leaves, while the bracts of the floral axes may bear small pinules proving the complete transition. The peduncular axes are really sizable branches. They emerge freely below the crown and reach large size. The main stem, though at first taken as simply columnar, may just as well be called ex-current with profuse branching. Measurements are here most instructive. A stem 25 cm in height with a woody cylinder only 8 cm in diameter and a thin cortical region bears an "armor" mass of small frond bases and many large bract invested peduncles or branches 15 cm in depth. The reproductive branches make up by far the greater bulk.

Fifthly, on the Fossil Cycad National Monument Mesa for the first time a serious quarrying operation was carried out with the aid of CCC help in November, 1935, bringing to light one ton of *in situ* specimens. Uneroded, unbroken, of varied specific type, nothing approaching such a collection has ever been seen before in the course of the even hundred years during which the cycadeoids have been better known as fossils. Rightly displayed in the field museum planned for the monument, this material alone will afford a singularly fine exhibit. There is a wealth of lesser leafed, branched and more generalized columnar types so highly instructive in tracing relationships and in proving how these plants, as fantastic as the cushion vegetation of the tropics or high mountains, may yet be traced through to their small-stemmed relatives of the Trias with a branching habitus like that of the magnolia.

Two types the botanist may do well to think of here are the branched *Williamsonia Dyeri* of the Trinity beds of Texas and a related long-known Jurassic species of the Paris Museum called *Clathropodium sarlatense.* The latter might be called *Cycadeoidea,* but is in no small degree an intermediate between that genus and *Williamsonia.* The heavy woody cylinder and relatively small medulla come near to more average gymnospermous woody stems. Small-leafed monument species like the *Cycadeoidea protea, C. minima* and *C. nana* also finely illustrate the transition.

Sixthly. The investigation of the marvelous petrified *Araucarian* forest of the Cerro Cuadrado, of north Central Patagonia, together with most important European studies, has led to a much broadened view of the floral morphology in the gymnosperms. Now at last it is seen how the cycadeoids, as seed fern derivatives, are far more nearly related to both the Cordaites and the conifers than was earlier even conceivable. In fact, the cycadeoids in their structural elements, both vegetative and floral, may be taken as left-overs from very ancient, even pre-Cordaites times. They show that the greater lines of seed plants were very much related to each other in their beginnings and that botanists must yet face the severe alternative of an all seed fern *vs.* all Lepidophyte origin for all the post-Paleozoic forest canopies. It's one or the other, with only a very minor chance that both great lines have shared in the long upward course. The more reasonable view is that the horsetails and club mosses of to-day are all that is left of the vegetation that in *Lepidostrobus* of Paleozoic times nearly reached the seed stage.

Here too must be mentioned the very instructive demonstration of the embryos of the Cerro Cuadrado Araucarians as brought out in the December, 1936, *Botanical Gazette* by Bertha Schweitzer Darrow. Mrs. Darrow shows that the two-cotyledon embryos of these older forms are typically Araucarian in feature. Thus is emphasized again the fact that the generalized embryo of the Araucarian is little different from that of the far older cycadeoids, however primitive polycotyledony and polyembryony may be. We are set visibly nearer some understanding of primitive embryonic factors and structures.

From the foregoing brief review it is seen that the cycadeoids of the Fossil Cycad National Monument are fundamentally important in botanical science. Furthermore, nowhere else so far have the specialized and heavy-stemmed branched types been found. Nor has a display of such gemstone beauty ever been brought together anywhere else on the globe.

Regarding the field conditions at the monument it merely remains to add that the location is a most sightly one and very accessible. At a moderate expense it can because of accessibility and surroundings be brought into a remarkable beauty of landscape, where the students may study at first hand in nature's own primitive setting the facts of the past, "the evidence that has never been tampered with by the hand of man," as Andrew Carnegie said. Furthermore, in addition to the plethora of material already had there is the sure promise of far more beneath the front mesa. The horizon is perfectly defined and traced around the monument borders. There are small shifts, slips or faults cutting these rim strata at various angles. But such have also tended to protect considerable material from loss by erosion. The cycadeoid level extends under fully three fourths of the entire monument area, while the trend of occurrence for the finest of the petrified stems indicates the presence within easy reach on the main mesa-capping of new material in excess of all ever recovered so far. One of the most splendid of all specimens, one of the most remarkable for beauty of silicification is the type *Cycadeoidea superba* which I secured absolutely *in situ* on the mesa cap at a point free from fault or shift for a long distance. Only shallow quarrying must reveal more such great specimens.

Fossil Cycad Monument more than all others of its series is as we now see dependent on an absolutely *in situ* development and display. Without this it can mean but little, as a mere blurred shadow, all but lost again in the shuffle of time. With it come into view a panoramic beauty, educational values of the highest and all that fuller realization of those far-away landscapes of dinosaur times, without some understanding of which we may scarce expect to learn or know life and ourselves.

What may the future wish and what do we owe? Shall we ourselves never develop the greater schools combining both exactitude and the open spaces? A recent summary shows that at the largest woman's college in the North (Hunter College of the City of New York) fully half the students preferred courses in some form of art. Here is time and here is nature in their highest expression. It is the artistic, trained sense that must best comprehend.

Just now, too, six students of the Yale Art School have in competition presented fully drawn-out plans for the monument field museum. All are of interest and merit. All show once and for all that the place for the monument display is on the monument itself and that there alone may a primary display be set to full advantage, there being as little reason for failure or going elsewhere as there would be for monumenting Gettysburg on other hills than where the historic action was fought.

The proposed Fossil Cycad National Monument development, as now quite definitely planned, will cost $65,000 initially. The question as to whence this money should firstly come was partly answered by the late Senator Norbeck, of South Dakota, who took the trouble to draft in preliminary form a bill providing for the planned development which he unqualifiedly favored. The plans, too, had the commendation of Mrs. Anna Wilmarth Ickes, who wrote the fine book "Mesa Land."

Meanwhile the visitor to the Black Hills is warned that without this development he can at present see next to nothing aside from fine "Rim" scenery at the monument, unless he is an extremely well-read and trained geologist. Above all, he need not go there, as many have done, expecting to quickly find and take away valuable specimens. Except for some mere accidental fragment meaningless to the layman, nothing is to be seen at the surface fulfilling the untrained conception of petrified forests.

G. R. WIELAND

YALE UNIVERSITY

BUILT-UP FILMS OF PROTEINS AND THEIR PROPERTIES

RECENTLY, Irving Langmuir, V. J. Schaefer and D. M. Wrinch[1] published in this journal experiments in which protein monolayers were deposited on chromium-plated slides, which were covered with several layers of barium stearate. By this procedure it was possible to build up several layers of protein films, which, depending on the method used, had either their lyophobic groups ("B" layer) or their lyophilic groups ("A" layer) exposed to the surface. From these experiments the following appear to be noteworthy and apparently open to objections:

(1) The protein layers were built up from films which were spread on distilled water and compressed to a pressure of 30 dynes per cm. (2) Lyophobic B-layers are wetted by water to the same extent as lyophilic A-layers. (3) PRBB layers can be obtained by suitable procedures, whereas it was impossible to build up PRAA layers.

According to Gorter,[2] Hughes and Rideal[3] and to my

[1] SCIENCE, 85: 76, 1937.
[2] *Proc. Acad. Sci. Amsterdam*, 29: 371, 1926.
[3] *Proc. Roy. Soc.*, 137A: 62, 1932.

own experience[4] homogeneous films can be obtained when proteins are spread on a salt solution having the P_H of the isoelectric point of the protein in question (egg albumin $P_H 4.8$). In no instance was it possible to obtain homogenous films—as observed through the ultramicroscope—on a surface of distilled water. Likewise, at salt solutions of $P_H 3$ or $P_H 7$ the protein films contained signs of inhomogeneities. It has been found also that films of egg albumen start to collapse at a pressure of about 18 dynes per cm.

In the light of these observations it seems to be possible that in those cases in which protein layers were built up from films which were spread on distilled water, and compressed to 30 dynes per cm, Langmuir, Schaefer and Wrinch were dealing with inhomogenous and collapsed films whose surfaces were to some extent both lyophilic and lyophobic. This would explain the observation that A and B layers are wetted equally by water and by lyophobic solvents, respectively.

Whereas it was not possible to build up PRAA.. films, it is surprising that the authors were able to build up PRBB... layers. In both PRAA.. and PRBB. . layers the lyophilic $-NH_3^+$ and $-COO^-$ groups of one layer would be attached to the lyophobic paraffin groups of the neighboring layer. On theoretical reasons these groups should exert relatively weak cohesive forces upon each other (ion-induced dipole) which probably could be overcome easily by the attractive forces between water and the lyophilic groups (ion-dipole) when such a polylayer is dipped into water. That the polar groups of proteins do not interact with lyophobic groups of other molecules has been suggested by experiments of the author—to be published shortly—in which the molecules of a mixed protein—fatty acid film occupy apparently the same area which they occupy when the compounds are spread alone. The question arises, therefore, whether or not the PRBB layers likewise consist of inhomogenous protein layers which to some extent are both lyophobic and lyophilic.

HANS NEURATH,
George Fisher Baker Research Fellow

CORNELL UNIVERSITY

A REAGENT FOR VITAMIN B_1

A PRELIMINARY report by McCollum and Prebluda[1] on a reagent for the detection and estimation of vitamin B_1 prompts me to send this note on a reagent for vitamin B_1 which I have been investigating for some time.

An investigation recently completed, and soon to be published, showed that the thiazoles form with potassium iodide a sensitive reagent for the detection of bismuth and antimony. It was also shown that a solution of bismuth iodide in potassium iodide is a sensitive reagent for thiazoles. Since Williams, Clarke and coworkers have shown that vitamin B_1 contains a thiazole fraction, it was suggested by Dr. Benjamin Harrow, of these laboratories, that bismuth potassium iodide be tested as a reagent for vitamin B_1.

This research was begun and a characteristic orange-red precipitate was obtained with the reagent and the following vitamin B_1 products: Fleischmann's yeast cakes, Squibb's malted wheat germ extract (vitavose) and Squibb's vitamin B and G syrup. Fresh orange juice, fresh grapefruit juice and canned tomato juice also gave a characteristic precipitate with the reagent. Certain brands of canned orange juice and canned grapefruit juice did not give the reaction. These products, when treated to destroy the vitamin, gave no precipitate with the reagent unless care was taken to preserve the thiazole nucleus.

The orange-red precipitate formed by the reagent with the above-mentioned products can be filtered, dried and weighed. The weight of the precipitate was found to be proportional to the amount of product used.

This work is being extended further, and complete details will be published later.

BARNET NAIMAN

COLLEGE OF THE CITY OF NEW YORK

THE EFFECT OF TEMPERATURE UPON THE RESPONSES OF PLANTS TO PHOTOPERIOD[1]

To furnish material for further studies of the relation of anatomical condition to blossoming,[2,3] more than 100 varieties of plants, including some monocotyledons, are being grown in different environmental and cultural conditions. The principal variables being used are photoperiod and temperature, although some partial defoliation, girdling, shading and low nitrogen treatments are also included. It appears that temperatures a little above or below the usual range employed in greenhouse culture have been effective in altering the responses of some plants which are commonly considered to have a fixed or definite reaction to relative length of daylight. For instance, poinsettia plants grown in the short days of winter at a temperature of 68° to 70° F. remained strongly vegetative and did not blossom, while plants in temperatures of 60° to 65° blossomed normally and plants in temperatures of

[4] *Jour. Phys. Chem.*, 40: 361, 1936.

[1] SCIENCE, 84: 488, November 27, 1936.

[1] Published with the permission of the director of the Wisconsin Agricultural Experiment Station.

[2] Ocra C. Wilton and R. H. Roberts, *Bot. Gaz.*, 98: 45–64, illus., 1936.

[3] R. H. Roberts and Ocra C. Wilton, SCIENCE, 84: 391–392, 1936.

55° to 57° show only slight tendencies to blossom (January 25). Plants which were moved from 63° (average), after forming blossom buds, to 70° abscissed their flower clusters. Large percentages of the poinsettia plants grown in long days at temperatures of 55° to 57° are producing blossoms. A similar departure from the usual responses to photoperiod occurred in the case of Klondyke cosmos. In previous years *Rudbeckia* plants have never produced stems when in short days but only a rosette of leaves. The plants in a cooler temperature this season are producing typical stems. These show no tendency to produce blossom buds, however; the plants in long days at cool temperature are forming abortive blossoms.

Other plants which have had their customary responses to photoperiod altered by temperature effects are: alfalfa (seed setting), winter barley, castor beans, wax beans, Chinese cabbage, chrysanthemum, white clover, geranium, hemp, Jimson weed, lettuce, pansy, pigweed, spring rye, spinach, stock, timothy and spring wheat.

R. H. ROBERTS,
BURDEAN E. STRUCKMEYER
UNIVERSITY OF WISCONSIN

SCIENTIFIC BOOKS

THE LUNG

The Lung. By WILLIAM SNOW MILLER. Charles C. Thomas. Baltimore, 1936. 209 pages. $7.50.

THE many friends and students of Dr. William Snow Miller will be delighted at the appearance of his book, "The Lung." Many have urged that he put into book form the knowledge gained from his long study of the anatomy of this organ. Some years ago the Committee on Medical Research of the National Tuberculosis Association provided funds with the hope that he could see his way clear to doing it. More recently Dr. Lawrason Brown gathered among Dr. Miller's friends funds for the same purpose. Now that it has come, it is beautifully illustrated and full of a wealth of knowledge.

Dr. Miller, as a great anatomist and no less keen historian, has combined these two talents in his book. Possibly the title, "The Lung," is a little too comprehensive, as the volume deals only with the anatomy, histology and architecture of the lung, and not with its living function. Nevertheless, the volume will do much to enable students to understand the fineness and delicacy of an organ which is difficult to visualize in detail.

All those students who have worked with Dr. Miller in his laboratory will miss in the photographs the depth and contrast made possible by the study of his actual models, which are such artistic pieces of work. They will not lack in understanding of the long, patient study of the structure of the lung, which he made by serial section, microscopic study, camera lucida drawings on scale paper to give exact proportions, for they will have seen Dr. Miller at work before finally completing his model with each system colored differently and checked against the serial sections. The skill with which these models have been conceived and executed have done what the author wished them to do—cleared up many vexed questions in lung and vascular architecture and lung function.

One very notable feature of Dr. Miller's work has been his ability to draw upon pathological material to illustrate many of the questions rendered difficult by histological methods alone. In particular is this true in determining the presence of an alveolar epithelial lining. This was accomplished by studying exudates in inflammatory conditions occurring between the basal membrane and covering cells of the alveoli, thus making clear the continuous epithelial covering.

Dr. Miller's work demonstrating the valves of the lymphatic system, which forces the flow in the lymphatics always in one direction, has always been helpful in understanding many pathological conditions. The different currents of the lymphatic flow in pleura and lung and his intimate study of elastic tissue layers has been invaluable also in understanding many pathological conditions.

The problem of anastomosis between the branches of the aortic system and pulmonary artery system Dr. Miller has also clarified. According to Dr. Miller's view, this probably only occurs in the capillary part of the two systems. The question of different blood supply to lymphatic tissue in different animals—for instance, by the bronchial artery in the rabbit and by the pulmonary artery in the guinea pig—probably explains in part the different distribution of tuberculosis in this disease in the two animals.

It would make too long a review to call attention to other interesting structures. It is possible that the book is too technical for many, but every student of anatomy and every clinician should have it for reference and should from time to time study it to clarify his picture of the fineness of this organ.

The historical division of this book every one interested in medical history will find delightful reading, but one thing is sure, that every one who has known Dr. Miller and his lifelong study in this field will be gratified that his knowledge has been put in such a satisfactory volume.

WM. CHARLES WHITE

NUCLEAR PHYSICS

Elements of Nuclear Physics. By F. RASETTI. New York: Prentice-Hall, Inc. $4.50.

WITH the publication of this and other books of the past year, the term "nuclear physics" may be regarded as having been officially admitted to the language. "Nuclear chemistry" seemed likely, for a time, to take the lead. Perhaps it would have been more appropriate on the whole, since a large part of the subject consists in reactions of transmutation for which the symbolism of chemistry is admirably fitted, and another part consists in measurement of the masses of atoms; but after all, almost the whole of the subject is a gift of the methods of physics to the sum of knowledge, and it would certainly ill beseem a physicist to complain.

Professor Rasetti, now of the University of Rome, was known as a notable experimental physicist even years before he belonged to the group at Rome which, with Fermi at their head, investigated transmutation by neutrons on a grand scale and discovered the enhanced transmuting power of slow neutrons, as well as much else. He is a familiar figure in this country, both in East and West. His English as exhibited in this book is flawless, though the style is dry and austere, largely because of the extreme condensation; for the book is packed with information, and scarcely a word is dispensable.

First (after a brief introduction) we find an account of the apparatus used for detection of fast-moving charged particles. Then come two chapters on what was formerly called "radioactivity" *tout court,* but must now be called "natural radioactivity"; taken together, they give a better share of the book to natural radioactivity than is frequently given nowadays, when so many writers are in haste to get to phenomena of newer interest. The latter of the chapters contains an account of alpha, beta and gamma ray spectra and of the Gurney-Condon-Gamow theory of the alpha-particle emission. Between them is inserted a long section concerning the interactions of alpha, beta and gamma rays with the atoms which they traverse or the electrons near which they pass, and including the creation and "annihilation" of electron-pairs (why must people speak of electrons being "annihilated" when their mass and energy go over into equal mass and energy of light?) Future classifiers of physics may take these topics out of nuclear physics altogether; for the present, it is relevant to insert them. Next come the tabulations of the masses and spins of the nuclei, with an exceedingly brief outline of the ways of measuring them. Next come two chapters on transmutation—an unexpectedly small share of the book! A considerable number of reactions are quoted, and there is a table of artificial radioactive substances. The book ends with a very concise account of cosmic rays.

The book is definitely an advanced text; students of the experimental side may find that all they require is the power of concentrated attention, but for the theoretical parts a grounding in quantum mechanics is needed. Readers already having some knowledge of the earlier stages of quantum theory will be glad to find the theories of scattering (after Born) and of penetration of potential barriers expounded without these usual preliminaries; and there is a good outline of the Heisenberg and Majorana theories of intra-nuclear interactions, and of the present state of the theory of the energy-loss suffered by fast electrons as they progress through matter. The author withstood too well the usual temptation of authors to lay undue stress on their own researches; one would like a fuller account of the work of the Roman school. The part about the Compton effect must have been written just too early to include the recent tests of the simultaneity of the recoils of electron and photon. The list of the naturally radioactive elements excludes all of atomic number less than 81, but for potassium, rubidium and samarium; it is not clear whether this represents a definitely adverse judgment of the author as to claims recently made for other elements.

KARL K. DARROW

SPECIAL ARTICLES

STUDIES ON THE PRODUCTION OF ANTIBODIES IN VITRO

IN 1912, Carrel and Ingebrigtsen[1] cultivated the bone marrow and lymph glands of guinea pigs in homologous blood plasma to which were added small amounts of red cells from the goat. On the fifth day, the culture fluid hemolyzed red cells from the goat without the addition of complement. After being heated at 56° C., the culture fluid lost its hemolytic power. Then, by addition of complement, this lost power was regained. On the basis of these and other tests, it was concluded that immune hemolysins had been formed. Since that time, numerous investigators have employed this direct method of adding the antigen to the tissue at the time of explantation. Some have reported positive results, others negative. A quite recent paper by Salle and McOmie[2] records negative findings in experiments in which chick embryonic tissue and rabbit or guinea pig spleen and lung were

[1] A. Carrel and R. Ingebrigtsen, *Jour. Exp. Med.*, 15: 287, 1912.

[2] A. J. Salle and W. A. McOmie, *Jour. Immunol.*, 32: 157, 1937. (Extensive bibliography.)

cultivated in media containing heterologous sera or foreign red cells.

Still other investigators have worked with tissues taken from animals that were injected with the antigen before explantation. Lüdke[3] injected killed cultures of typhoid bacilli into rabbits and guinea pigs, removed fragments of the spleen and whole femur after from 24 to 60 hours and incubated them in various culture media. After from 2 to 5 days, he was able to detect agglutinins in extracts prepared from the spleen and bone marrow. Przygode,[4] Reiter[5] and Meyer and Loewenthal[6] have also reported antibody production in tissues removed after injection of the animal. In contrast, however, similar attempts by Kuczynski, Tenenbaum and Werthemann[7] were unsuccessful. The experiments described in this paper were undertaken to reinvestigate the problem, utilizing recent improvements in the tissue culture techniques.

Fragments of adult rabbit spleen removed from animals injected 2 and 3 days previously with washed guinea pig red cells were found to produce easily demonstrable agglutinins against guinea pig red cells after 4 days' incubation in a fluid medium. The medium consisted of 3 parts "normal" rabbit serum, 1 part isotonic sodium bicarbonate (1.4 per cent.), 2 parts Tyrode's solution containing 4 times the usual amount of glucose, and 0.005 per cent. phenol red to serve as an indicator. For each culture, approximately 100 mg of tissue (75 fragments) were suspended in 2 cc of medium contained in H-8 Carrel flasks. These flasks have a total capacity of about 70 cc. In addition to the fluid medium, each culture was supplied daily with an atmosphere consisting of 80 per cent. O_2, 8 per cent. CO_2 and 12 per cent. N_2. The high concentration of O_2 is necessary in order to keep the fragments alive. The CO_2 acts together with the rest of the medium to keep the pH constant at 7.2. This method of cultivation[8] makes for functional survival of the tissue fragments without any marked proliferation of the constituent elements.

The serum in which the tissues were cultivated was usually taken from one or more untreated rabbits that had previously been found to contain at most mere traces of natural agglutinating antibodies against guinea pig red cells. But occasional use was made also of autologous serum taken from the injected animal at the time the spleen was removed. As controls, all culture media were incubated without tissue for the period of the experiment. Additional controls consisted of duplicate cultures kept at 4° C. Ordinarily, all these yielded negative tests, whereas hemagglutinins produced by the tissues were detected in the culture fluid in various dilutions sometimes as high as 1:320. Furthermore, no increase in antibody output was ever obtained by using serum from animals whose spleens had previously been found to produce antibodies in more than moderate amount.

Under the same conditions of cultivation, adult rabbit spleens taken from animals injected 1 to 24 hours previously with washed guinea pig red cells failed to produce demonstrable antibodies. This indicated the possibility that the production of antibodies outside the body may be dependent upon certain reactions occurring within the organism and that these reactions must reach a certain stage before the process can readily be completed *in vitro*.

Negative results were obtained also when spleens taken from animals injected 24 hours previously were cultivated in the sera of rabbits injected three days previously with a proportionate amount of the same antigen. This was true even when the serum in which they were cultivated had been taken from animals whose spleens had produced demonstrable antibodies in dilutions as high as 1:256 and 1:320 when cultivated in normal serum. It appears then that if the serum of an animal injected three days previously contained certain necessary substances not present after one day, these substances were incapable of acting together with tissues that had not undergone the same period of preparation.

Next, an attempt was made to shorten this period by first injecting a bacterial antigen (*V. metchnikovi*), followed several days later by the washed guinea pig red cells. But when the spleens were removed for cultivation 24 hours after the last injection, they still failed to produce agglutinins against the foreign red cells.

Other experiments were made in which the spleen was perfused with the antigen by injecting it directly with the foreign red cells by way of the splenic artery. After from five to ten minutes, the spleen was removed and cultivated in the usual manner. Again, the results were negative.

Interesting observations were made also in the matter of animal individuality. When sera from different animals were used in the cultivation of tissues taken from a single organ, some proved to be excellent culture media, whereas others were decidedly toxic. It was found also that tissues removed from different animals that had been injected previously with proportionate amounts of the same antigen may, upon cultivation in a given sample of serum, remain in an equally good state of preservation and yet differ in antibody response.

[3] H. Lüdke, *Berl. klin. Woch.*, 49: 1034, 1912.

[4] P. Przygode, *Wien. klin. Woch.*, 26: 841, 1913.

[5] H. Reiter, *Z. Immunitätsforsch.*, 18: 5, 1913.

[6] K. Meyer and H. Loewenthal, *Z. Immunitätsforsch.*, 54: 420, 1928.

[7] M. H. Kuczynski, E. Tenenbaum and A. Werthemann, *Virchows Arch. path. Anat.*, 258: 687, 1925.

[8] R. C. Parker, SCIENCE, 83: 579, 1936.

Some of the experiments reported above were also performed using bacterial antigens. The results were similar to those obtained when foreign red cells were used.

Finally, attempts were made to repeat the experiments of Meyer and Loewenthal,[6] who reported antibody production in hanging drop cultures of spleen taken from rabbits injected one hour previously with bacterial antigens. Although all the older procedures were carefully adhered to, the results were entirely negative.

In view of the positive results obtained when the antigen was allowed to remain for two to three days in the animal, the negative results obtained when this period was shortened have a very definite significance. They not only suggest that antibody production is a more complicated process than is usually assumed, but they imply that it is not easy to demonstrate a production of antibodies *in vitro* unless the tissues have first been acted upon by some unknown mechanism within the body.

All the serological tests in the course of these experiments were made under the supervision of Dr. Karl Landsteiner, upon whose experience the plan of investigation was entirely dependent.

RAYMOND C. PARKER

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH
NEW YORK, N. Y.

PREPARATION OF AN ACTIVE AGENT FROM INACTIVE TUMOR EXTRACTS

THE majority of fowl tumors of spontaneous origin which have been transplanted have proved to be transmissible by cell-free filtrates or desiccates of the tumors. On the other hand, chemically induced fowl tumors, with the exception of three reported by MacIntosh,[1] are transferable only by grafts of living tumor cells. In this respect the latter resemble the mammalian tumors. It has been shown in this laboratory that not infrequently the low activity of filtrates or desiccates, occasionally encountered in transmitting the filterable tumors, is due to the presence of an inhibiting factor rather than the absence of the agent. This was established by the fact that the removal of the inhibitor by adsorption on alumina gel rendered the extract highly active in tumor production.[2] However, this method failed to explain the non-filtration of a slow-growing fibro-sarcoma (Chicken Tumor 10) which has been under observation in this laboratory for the past ten years. A strong inhibitor has been shown to be present in this tumor by cross tests with Chicken Tumor I, but treatment of extracts with alumina gel failed to render the extracts active in the transmission of the tumor. Yet there was a suggestion that the tumor possessed a transmissible agent from the fact that once or twice tumors resulted from injection of desiccates, but this was a rare occurrence and there was no clear-cut transmission by filtrate in the many attempts which have been made.

In recent studies of Chicken Tumor I, it has been shown that the agent could be sedimented by high-speed centrifugation, and this method seemed clearly to separate the agent from its own inhibitor.[3] This observation suggested a further attempt to transmit the fibro-sarcoma.

Experiment: A water extract was prepared from an eight-week old Chicken Tumor 10 and the extract passed through a Berkefeld V candle. The filtrate was submitted to a centrifugal force of 14,000 times that of gravity for 2½ hours. The resultant sediment was taken up in Tyrode's solution and redeposited at high speed. This washed sediment was next suspended in a volume of Tyrode's equal to 1/10 that of the original filtrate. For activity tests, 0.4 cc of the suspension were injected into normal hens, the same birds also receiving the same amount of the original filtrate in another area for control. No tumors developed as the result of injection of the unspun filtrate. Tumors did arise in 50 per cent. of the areas injected with the washed sediment, reaching a size of 3.1×2.3 cm within 40 days. Later some of them retrogressed. The histology of the original tumor was duplicated in the induced tumors.

In a second experiment an extract was prepared from a desiccate of Chicken Tumor 10, and this extract was treated in the same manner as that described above. Again the unspun extract gave negative results, while the injection of the washed sediment resulted in 33 per cent. positive results.

That the production of tumors in these experiments was not simply an effect of concentration of the agent was shown by the following test. The supernatant fluid, depleted of the agent, was saved. Part of the sediment, after being washed and resuspended in Tyrode's solution, was mixed with an equal volume of the original supernatant fluid. The remaining sediment was diluted to the same degree with water as a control. The injection of the diluted sediment gave positive results in 50 per cent. of the areas injected, while the part diluted with the original supernatant fluid failed to induce tumors in any of the areas injected.

The complete neutralization of the active sediment by its own supernatant fluid indicates that the failure

[1] J. McIntosh, *Brit. Jour. Exp. Med.*, 14: 422, 1933.

[2] Jas. B. Murphy, O. M. Helmer, A. Claude and E. Sturm, SCIENCE, 73: 266, 1931.

[3] A. Claude, paper in press.

of the original extracts to produce tumors was due to the presence of inhibitory elements in the solution. The fact that agent and inhibitor can be separated by physical means would suggest either that the agent is not modified by its inhibitor or that the reaction between them is easily reversible. Whether or not this centrifugation method will separate potent agents from hitherto non-filterable tumors will be determined by further tests. So far, preliminary experiments with mammalian tumors have given negative results.

ALBERT CLAUDE

ROCKEFELLER INSTITUTE
NEW YORK

THE FEEDING OF HOLLOW-SPEAR NEMATODES ON OTHER NEMATODES[1]

THE habit of preying upon nematodes has been found by the writers to be well developed in two groups of nematodes in which it appears not to have been recorded: the genus *Aphelenchoides* Fischer, 1894, and the dorylaim genera *Dorylaimus* Dujardin, 1845, *Discolaimus* Cobb, 1913, and *Actinolaimus* Cobb, 1913. Equipped with hollow, protrustive oral spears or stylets, predators of these genera feed, not as do the types formerly recognized as feeding on nematodes, but rather by inserting their spears into their prey and holding them there while sucking out the body contents. The relatively large dorylaims, with their coarse spears and powerfully muscular esophaguses, disorganize their prey so quickly that there is little opportunity for struggle. The rather small Aphelenchoides, on the contrary, feed slowly, and here the evidence is definite for one species that the prey is paralyzed almost instantly when the very slender stylet is inserted, so that struggles are prevented. During the feeding of two species of Aphelenchoides, saliva has been seen flowing out from the large dorsal esophageal gland, through the esophageal tube and into the prey.

Soil-inhabiting nematodes formerly recognized to be predacious on other nematodes, such as species of *Mononchus* Bastian, 1865, and *Diplogaster vorax* Goodey, 1929, are equipped with fine grasping teeth, with cutting teeth or with both. Slender mural teeth which slash into prey but are withdrawn while feeding are possessed by the genera *Nygolaimus* Cobb, 1913, and *Sectonema* Thorne, 1930, which are known from the work of Thorne[2] to prey upon oligochaet worms. Cobb,[3] in listing 16 genera of predacious free-living nematodes, most of which are marine forms, mentioned "Pharynx with acute clutching organs—onchia or denticles" as characteristic of such genera. Of these genera, only *Dorylaimus* feeds through a hollow oral spear.

Dorylaimus was included in Cobb's list of carnivorous forms, despite its lack of clutching organs, on the strength of his simultaneously published record of two nemas of this genus feeding upon mite eggs; of Steiner's[4] earlier record of a seta of an oligochaet worm in the intestine of *Dorylaimus regius* de Man, 1884; and of Thorne's[5] finding three instances of *Heterodera schachtii* Schmidt eggs impaled on the spears of young *Dorylaimus obtusicaudatus*.

We have repeatedly observed various species of this genus and allied genera, including larvae and adults of both sexes, feeding upon other nematodes including larvae of *Heterodera marioni* (Cornu) Goodey, 1932. All these observations, with two minor exceptions, have been in Petri dishes of agar. Unlike predators capable of grasping or slashing their prey, these forms which suck their food through hollow spears seem unable to capture prey suspended in water, for considerable pressure is required to thrust their relatively coarse, hollow spears into other nematodes. Even a very soft agar is unsatisfactory, the prey being pushed through the medium by the spear instead of being penetrated.

A predacious dorylaim finds its prey only by chance, but when its head makes contact with another nematode it responds immediately. It orients its head at right angles with the surface of the prey, so that its lips make firm contact, then protrudes its spear suddenly in an attempt to penetrate, and may do so repeatedly if not immediately successful. Once the spear enters the body of the prey it is held there while the heavily muscular esophagus of the predator begins a rhythmical sucking action which quickly disorganizes the body contents of the prey, sucking them out and leaving an empty, collapsed body wall.

A dorylaim holds its spear extended far into its prey, even during the periods of rest which alternate with periods of sucking. With a medium to large dorylaim, the spear tip reaches to the opposite body wall of such nematodes as the larvae of *H. marioni*. Such a position is advantageous in view of the long diagonally placed opening on the side of the spear.

Some of these predators have also been seen feeding on nematode eggs, both of *H. marioni* and of various free-living forms. When egg masses of the former are placed in agar dishes they prove most attractive to at least some of these species.

The predators in question have not yet been identified specifically, but it is our judgment that ten species of *Dorylaimus*, two of *Discolaimus* and one of *Ac-*

[1] Published with the approval of the director as Technical Paper No. 97 of the Pineapple Experiment Station, University of Hawaii.

[2] G. Thorne, *Jour. Agr. Research*, 41: 445–466, 1930.

[3] N. A. Cobb, *Jour. Parasitology*, 15: 284–285, 1929.

[4] G. Steiner, *Jour. Agr. Research*, 28: 1062–1064, 1924.

[5] G. Thorne, *Jour. Agr. Research*, 37: 575, 1928.

tinolaimus are now represented in our collection of individuals which have been preserved after having been seen feeding on other nematodes. These represent collections from pineapple fields, gardens, wet forest and arid waste land on the island of Oahu and from association with weed roots from Christmas Island, a small coral atoll lying at 21° 57′ N., 157° 27′ W. Further details with specific identifications will be reported later.

From observations on their occurrence in Hawaiian pineapple fields it appears that these dorylaims are vastly more important as predators than species of *Mononchus*. Cassidy[6] reported four species of that genus from pineapple field soils, but these are very rare. The dorylaim genera *Dorylaimus* and *Discolaimus*, on the contrary, are generally present and often numerous. For instance, a sample of 252 grams soil with 46 grams roots from under a single pineapple plant contained dorylaims of two species at the rate of 1.3 per gram, but no specimen of *Mononchus* was found.

The predacious species of *Aphelenchoides* are more remarkable in several ways, being morphologically very similar to several plant-parasitic species and being members of a group in which no predacious tendencies seem to have been suspected. The genus includes species parasitic on higher plants as well as at least one fungus-sucking species.[7] Some other species are free-living forms of unknown food preference but commonly regarded as saprophytic.

We have found two species of this genus to be highly specialized predators which, given a sufficient population of prey, multiply rapidly in agar culture. Both are cultured readily by transferring them to cultures of *Aphelenchus avenae* Bastian, 1865, or *Aphelenchoides parietinus* (Bastian) Steiner, 1932, previously established in an agar culture of a suitable fungus. Neither predator feeds on fungi.

One of these species appears to be *Aphelenchoides tenuicaudatus* (de Man, 1895) Goodey, 1933, while the other may require description as a new species. Both have very slender hollow stylets, with which they penetrate their prey and through which their food is drawn. *A. tenuicaudatus* attacks nematode eggs as well as larvae and adults, while the other appears to feed only on nematodes.

These two predators are both small, well under one millimeter in length, but they attack successfully larvae of *H. marioni* and both adults and larvae of *Anguillulina pratensis* (de Man) Goffart, 1929, as well as of various free-living species including forms larger than themselves. Both species appear to exert a paralyzing action on their prey, which helps to compensate for their inferior size, for nematodes penetrated by the stylet become inactive almost immediately and lie still during the relatively slow process of being sucked out.

Paralysis of prey was clearly indicated for the undescribed species of *Aphelenchoides* when a larva only one hour old was seen to pierce an *A. avenae* twice its own length. This prey was moving rapidly at the time, so that the predator lost its hold and its stylet was within the prey for only an instant; still this nematode stopped in half its own length and lay quiet for several hours before being fed upon by another predator.

Such paralysis probably results from an injection of saliva from the predator. No injection at the instant of penetration has been seen, but repeated salivary injection during feeding has been observed in many instances with both species of *Aphelenchoides*. The saliva itself has come from the dorsal esophageal gland, which is highly developed in this genus.

During periods of active sucking and continuing into the many alternating periods when the esophageal bulb is at rest, saliva may be seen flowing anteriorly from the long dorsal esophageal gland, through a slender noncuticular duct dorsad of the intestine, and into the posterior end of the esophageal bulb dorsad of its lumen. Here the duct widens, and the saliva is seen to continue its anterior flow within the confines of the bulb but dorsad of its cuticular crescentic plates, and to enter the anterior nonstriated part of the bulb. In both species this part is distinctly alveolate, and into its cavities the saliva flows. Accumulation here is apparent while the muscular part of the bulb is at rest. This alveolate region may be seen to twitch irregularly as it fills, and after it is filled some return flow from it posteriorly towards the dorsal gland often occurs.

As soon as the muscular bulb resumes activity, saliva again flows anteriorly from the dorsal gland. Presumably some of this saliva enters the lumen of the esophagus and mixes with the food rushing posteriorly towards the intestine. Very clearly, however, during momentary interruptions of the inflow of food, some of it rushes anteriorly from the bulb through the lumen of the esophagus and stylet and into the body of the prey where it appears to start the process of digestion. These details have been observed repeatedly in both predacious species of *Aphelenchoides*.

These observations of saliva flow lend great weight to the hypotheses of various investigators to the effect that pathological states arising from nematode infestations result, at least in part, from an outpouring of salivary secretions.

[6] G. Cassidy, *Hawaiian Planters' Record*, 35: 305–339, 1931.

[7] J. R. Christie and C. H. Arndt, *Phytopathology*, 26: 698–701, 1936.

After this note was submitted for publication, Mr. Gerald Thorne, of the United States Bureau of Plant Industry, who was sent a manuscript copy, wrote as follows (personal communication): "There are many species of *Discolaimus* and *Actinolaimus* in my collections . . . which I know to be predacious. But it was only about a month ago that Mr. McBeth . . . saw our first *Aphelenchoides* feeding on another nema."

M. B. LINFORD
J. M. OLIVEIRA
PINEAPPLE EXPERIMENT STATION
HONOLULU, T. H.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CIRCULATION PUMP[1]

IN a series of experiments on adrenaline secretion[2] need arose for a pump with which to pump the blood from the adrenals of a cat into its carotid artery. A description of the main features of this pump, which has been found to function satisfactorily and which can be used for the perfusion of organs with blood or other fluids or for the maintenance of the circulation of a whole animal, follows.

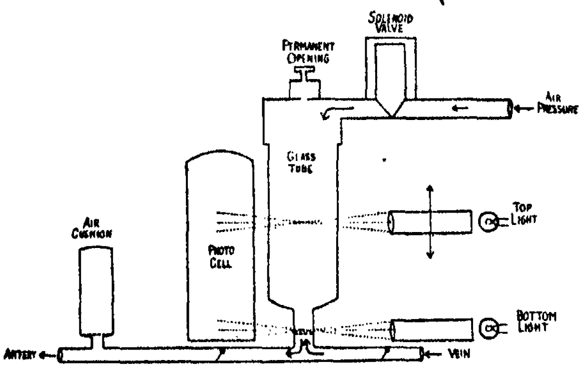

FIG. 1

The blood, leaving the vein, enters a vertical glass-tube. Its top is connected with the outlet of a solenoid air-valve, the inlet of which leads to an air-cylinder. When this valve is opened, the pressure, delivered by the tank, acts on the blood in the glass-tube and pumps it out. Two glass-valves direct the blood from the tube into the artery during the systole and prevent back flow from the latter during the diastole of the pump. When the glass-tube is emptied the air-valve is closed, and new blood is thus allowed to enter.

The air-valve is opened and closed by a photo-electric cell activated by two beams from two light sources, which pass through the glass-tube and can be interrupted by the blood column. These light-beams are focussed by lenses in such a manner that one passes through the bottom of the tube, while the other one is focussed on it at any desired height above. The wiring of the relay-contacts of the photo-electric outfit, the solenoid valve and the light sources result in the following operations of the pump. During systole the air-valve is opened and the top-light is out. Air pressure pumps the blood out of the tube into the artery until the blood column reaches the beam of the bottom-light. This beam is thus allowed to pass through the glass-tube and activates the photo-cell, which then closes the air-valve and switches the top-light on. During the ensuing diastole the top-light keeps the solenoid-valve closed until the rising blood level cuts the light off the photo-cell, which, by opening the pressure valve and switching the top-light off, starts the next systole. A narrow permanent opening at the top of the glass-tube allows the blood to replace the air enclosed in the tube during the diastole.

The output per stroke is determined by the height at which the top-light-beam passes the glass-tube. With each stroke, the tube is emptied, since the lower beam passes through the lowest part of the glass-tube. Increase or decrease in venous return are answered by a corresponding change in rate. The desired systolic pressure is adjusted by the reduction valve at the pressure tank. A large inside diameter of the glass-tube prevents significant changes in venous pressure, as small changes in level correspond to large changes in volume. An air-cushion chamber as used in other circulation pumps between arterial valve and artery maintains blood flow and pressure during the diastole. By placing the lower end of the glass-tube below the level of the vein, a slight suction may be obtained, which facilitates venous return. The parts of the pump which are placed close to the animal in order to avoid dead space in the connections between pump and vessels are: the two flow-valves, glass-tube, which by means of a metal fitting is screwed into the bottom of the air-valve, the two light-bulbs with lenses and the photo-electric cell (see Fig. 1). These parts are mounted on a metal holder and connected with the rest of the set-up by cables. All parts conducting blood can be heated electrically. They may also be kept sterile. We have used the pump with a maximum speed of about 100 strokes per minute, although usually a lower rate was preferred.

This pump resembles the artificial heart of O. S. Gibbs,[3] as with a constant, but adjustable output per stroke its output per minute depends on the venous return. Unlike the Gibbs-pump it avoids the contact of rubber with the blood. All the major parts used

[1] Aided by a grant from the David Trautman Schwartz Research Fund.

[2] Gerhard Katz and Gertrud Katz, *Jour. Pharm. and Exp. Therap.* (in press).

[3] O. S. Gibbs, *Jour. Pharm. and Exp. Therap.*, 38: 197.

are commercially available and comparatively inexpensive.

GERHARD KATZ
TULANE UNIVERSITY
SCHOOL OF MEDICINE

A NEW TECHNIQUE FOR THE STUDY OF DROSOPHILA EGGS AND LARVAE

WHILE carrying on hybridization experiments on two subspecies of *Drosophila virilis* it was suggested to the writer by Dr. A. H. Sturtevant that egg counts be made. In attempting to improve on the present technique of egg collection it was discovered that a fly will readily deposit her eggs through cloth mesh onto the proper medium. To make use of this fact

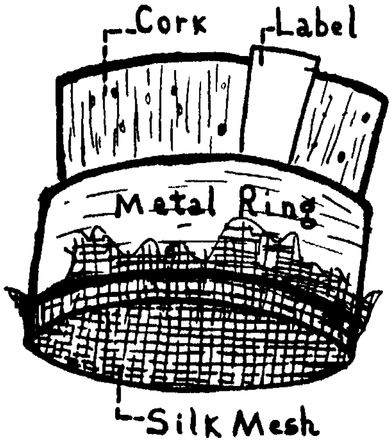

FIG. 1

the apparatus shown in the figure was devised. It is a tiny Drosophila cage, consisting of a metal gas-hole ferrule or ring ⅞ inch in diameter and ½ inch high. Over one end of this ring is stretched tightly a piece of black silk bobbinette, trade No. 400 for large species of Drosophila and No. 418 for small species. This silk net is held in place by a rubber band. Into the smaller end of the ring fits a cork of such a size that it projects part way into the ring. The label may be written on a small slip of library card which fits between cork and ring. This ensures a sufficient air supply.

In most experiments one female per cage is used. For securing eggs the cage is placed directly on the medium and the fly lays her eggs through the silk mesh. Few if any eggs stick to the mesh, and these may be seen against the black background. The medium of corn-meal molasses agar or banana agar with a little animal charcoal added for contrast is poured into a small waterproof paper plate of a size conveniently examined on the stage of the binocular. Yeasting is done by spraying a fine suspension from an atomizer onto the plate shortly before using. The medium should contain an extra supply of agar to ensure stiffness and to keep the silk from getting wet.

Several experimental cages may be placed on the same plate. To guard against contamination an inverted paper plate covers the apparatus and is held in place by paper clips or rubber bands. After a given time the cages are lifted off and transferred to a fresh agar plate. The egg output of each female is then counted. If the experiment calls for the rearing of larvae a piece of the medium containing a certain number of eggs is cut off and placed with food in a culture vial or bottle. The agar plate may then be covered, and from time to time egg hatching and early larval stages examined directly under the binocular.

This apparatus has advantages in the collection of large numbers of eggs and larvae, life history studies and various problems dealing with the rearing of Drosophila. Its use facilitates the introduction of quantitative methods.

WARREN P. SPENCER
CALIFORNIA INSTITUTE OF TECHNOLOGY

THE EAR-OSSICLES IN CRANIA

IN removing crania, human, or other, from fossil areas, the ear-ossicles have not been looked for in the surrounding earth, or still within the cranium. But in handling the temporal bone the ossicles may fall out unless cotton at once be placed in the external auditory canal. By such care a stapes was recovered from the left temporal of Lake Pelican man, Otter Tail County, Minnesota. This is an appeal to excavators to place cotton in ear-hole at once, and to examine earth for specimens.

THOMAS HORACE EVANS

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LARGE MOLECULES IN SCIENCE AND LIFE[1]

By Professor HUGH S. TAYLOR
PRINCETON UNIVERSITY

IT is a striking characteristic of the gaseous substance, acetylene, with which Father Nieuwland spent so much of his later scientific life, that, under the influence of a variety of agencies, light, radioactive rays, cathode rays, the silent electric discharge and, also, even contact agents such as a copper catalyst, the gas changes to an insoluble yellowish solid known as cuprene. It received its name because Sabatier, who prepared it from acetylene with the aid of a copper catalyst, thought that it contained copper. It is now known that it contains no copper, but, within the error of analysis, a one to one ratio of carbon to hydrogen, as does acetylene. How different the properties! In place of a highly reactive gas we have a chemically inert solid, the linkages of which are all so mutually satisfied that it has hitherto resisted all efforts to bring it into solution in any known solvent, although hundreds of such have been tried. All the properties of the simple molecule, with the study of which Father Nieuwland spent so many happy and fruitful days, have disappeared in the formation of something which we may speak of as giant molecules, each particle of the cuprene composed of three-dimensional arrays of the carbon and hydrogen atoms of which it is composed. Acetylene is the simplest of the compounds from which, in these hectic days of industrial scientific progress, large molecules or polymers, with a fascinating range of properties, may be prepared, synthetic rubbers, plastics, fibers and the like.

It is not alone, however, in the industrial scientific field that the large polymeric molecules possess great significance. In biological systems and in organic matter generally, it is now known that highly polymerized systems constitute an important fraction of such material and that their properties, including tensile strength, elasticity and flexibility, durability, resistance to chemical change, hardness, confer on such bodies a

[1] An address delivered at the Father Nieuwland Memorial Exercises at the University of Notre Dame on January 10, 1937.

wide variation of desirable properties. In inorganic systems also, as in diamond and graphite, silica and the silicates, including varieties with such divergent properties as crystal quartz, mica sheets, asbestos fibers, we find examples multiplied of the manifold properties which may be conferred on material of the same unitary composition when built up by repetition of the unit in one, two or three dimensions into the larger aggregates of naturally occurring minerals and products.

Science to-day is facing boldly the difficult problems that the investigation of such complexities of structure bring in their train. The wonderful achievements in the organic chemistry of biologically important compounds with the syntheses of such substances as the vitamins and hormones can not obscure the fact that the problems that still lie ahead, involving the molecules of an entirely higher order of complexity, the proteins, the viruses, enzymes, cellulose, require for their solution the best cooperative efforts of the biologist, the physicist, the organic and inorganic chemist; nor is it beyond the bounds of possibility that the mathematician with his specialized knowledge in the field of topology will also be called in to assist. Only in special cases will the ordinary synthetic and analytic studies of classical organic chemistry suffice for the problem in hand. Greater progress will occur when such is combined with kinetic, stereo-analytical and colloidal techniques that the other sciences will contribute.

In the field of inorganic matter it is the diffraction of x-rays by solid matter that has been, in the past two decades, so intensely revealing. These rays of light, commensurable in wave-length with the distances between atoms in the solid structures studied, have revealed the diamond, hardest of known substances, as a tetrahedral array of carbon atoms in one giant molecule, each atom equally spaced from four neighbors arranged at the corners of a tetrahedron of which the fifth atom occupies the center. The distance from carbon atom to carbon is identical with that between carbon atoms in the paraffinic hydrocarbons of a straight run Pennsylvania gasoline, with about the same energy of bonding. This is a strong bond, and it is the symmetry of this bonding in all directions throughout the diamond aggregate that confers upon it its two conspicuous properties, its intense hardness and its lack of volatility. In graphite, this symmetry is destroyed and the analysis of the atom spacing reveals the causes of the new properties. There is a hexagonal array of carbon atoms in flat planes similarly spaced to the carbon atoms in a benzene ring, but between planes the distance is from two to three times that between atoms in the ring. It is along this plane of great distance that cleavage can occur, accounting simply for the flaky characteristics of the mineral.

In crystal quartz and in the silicates, the x-ray reveals a similar regularity of architecture. The silicon atom in this case is always located between four oxygen atoms. In certain silicates, this array of five atoms, SiO_4, forms a tetrahedral array similar to that discussed in the case of diamond. The oxygen atoms may, however, act as bridges between two silicon atoms and numerous possibilities result. Two tetrahedra may be linked through one common oxygen atom which is common to two silicons and form a unit, Si_2O_7, to build into a more complex structure with other units. Three may form a ring, Si_3O_9, and six may form another type of ring, Si_6O_{18}. If the edges of two tetrahedra are linked by two common oxygen atoms a chain or filament or fiber, with a formula $(SiO_3)_n$, where n may be indefinitely long, is formed. Two chains linked side by side give a band of which the unit composition is Si_4O_{11}. Sheets, like mica, belong to the class of linked tetrahedra, each tetrahedron sharing three corners, with composition $(Si_2O_5)_n$. If all four corners are shared with other tetrahedra (as in diamond) the extension occurs in three dimensions, crystal quartz results and the composition is a giant molecule $(SiO_2)_n$.

Alumina can replace silicon in these structures, the tetrahedron acquires a negative charge and so can associate in the crystal architecture with positive metal units. The felspars are of this structure. Zeolites, such as permutit, are more open structures containing water molecules within the crystal architecture; these open structures permit replacement of the positive units, a circumstance which determines their use for water softening.

From such deductions based upon x-ray analysis of inorganic matter there is a ready transition to the corresponding structures in naturally occurring and synthetic organic materials. The continuous linkages of molecules having one reactive group at each end will give rise to linear aggregates, filamentary or chain-like in character. Under favorable circumstances this type of reaction may give rise to ring formation or cyclization, with alternative spacial configurations of the resultant products. Molecules with a greater number of reactive units in the initial structure, so-called polyfunctional molecules, offer greater varieties of structural growth, extending into three dimensions. Acetylene may be regarded as having four-fold functionality and the cuprene would represent a three-dimensional growth of the aggregate. Divinyl acetylene, on the other hand, $CH_2=CH-C\equiv C-CH=CH_2$, illustrates the acetylene molecule in process of linear growth, with only half of its unsaturation contributing to the change. Oxygen, sulfur and nitrogen are important atom links in such aggregates of large organic molecules. Sulfur atoms are important links in the chains of atoms present in the technically important "thiokol."

The study of jellies, and of the gels which result

from them by controlled removal of the water content, represents another avenue of approach to the problems of large molecules employing the technique of the colloidal chemist. Here also x-ray investigations are an invaluable supplement to the physico-chemical studies of such structures. They reveal the structure or its absence in the aggregates obtained. Completely amorphous, crystalline and half-crystalline structures have been observed. The physical characteristics of the jelly undoubtedly depend on the same type of orienting forces, if quantitatively less strong, as are involved in the building up of the more robust structures. The zeolites may be thought of as a half-way house between the jelly and the large-molecule crystal.

The techniques of colloid-chemistry are invaluable also in the determination of the distribution of sizes amongst the polymer aggregates. In this regard, mainly due to the brilliant leadership of Svedberg, our knowledge is rapidly growing. By measurements of the rate of settling of the particles dispersed in a suitable liquid medium, either under the action of gravity or under the influence of centrifugal forces which may rise to many tens of thousands of times the force of gravity, we can learn whether the individual particles of a product, natural or synthetic, are uniform or non-uniform. If uniform, the rate of settling will be uniform and reveal itself as sharp-edged sedimentation. If the material be non-uniform, the lighter particles settle more slowly and a blurred boundary is obtained in the process. Size-classifications can be obtained in the latter case. The outstanding results of such studies by Svedberg and his collaborators lie, however, in the observations made with naturally occurring proteins, many of which, after suitable purification and under stable conditions, are found to be remarkably uniform in size. This implies that the units are identical chemically, are, indeed, single macromolecules. Svedberg's researches reveal, moreover, that the molecular weights of different proteins show a surprisingly simple relationship with one another. One series of proteins have a molecular weight of about 34,500. Another group have a value of about 68,000; a third averages 104,000, another group 208,000. Some have molecular weights of as high as 5,000,000.

In the general field of the large molecules, included under the term protein, the greatest scientific activity now obtains. Here, at its best, is exemplified, at the moment, that cooperative international effort in science in such marked contrast to the divisive, competitive struggles that separate nations in other fields. A great concentration of skills is being brought to bear upon the problem. The shapes and sizes and surface properties are being studied by observations of insoluble protein films on water. The velocities of protein reactions are being followed, practically and theoretically, in an effort to elucidate the mechanisms of interaction. Stanley's studies of the crystalline tobacco leaf virus are revealing the conditions necessary to the multiplication of protein material. Crystalline pepsin and trypsin, typical protein enzymes are steadily compelled to reveal the complexities of their structure and behavior. More recently still, from the ranks of the mathematician, from a topographical approach, Dr. Wrinch is discussing the pattern of protein structure, two-dimensional cyclol layers capable of extension in three dimensions by linkage front to front and back to back by side chains and hydroxyls, respectively, in a manner made familiar by the study of Langmuir and Miss Blodgett with oil films on saturated barium carbonate solutions. The pattern of the protein surface is being linked with the structure of the physiologically active substances, such as the carcinogens, sterols, sex hormones, as the substrate on which these latter may be superposed. Finally, the same protein pattern may be built up into closed globular structures which would define the uniformity of molecular weight determined by Svedberg in his studies and the particular magnitudes for these weights which the measurements reveal. All these varying techniques are available to assist the synthetic organic chemist in the development of his own rich efforts, so well exemplified in the person of him who to-day we have come from near and far to honor.

ENGINEERING IN AN AMERICAN PROGRAM FOR SOCIAL PROGRESS.[1] II

By Dr. KARL T. COMPTON

PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CONSERVATION OF NATURAL RESOURCES

We turn now to the third great feature of the American program for social progress, which is the conservation of our natural resources. To this end the Federal Administration has maintained a National Resources Committee which has made an extensive survey into every aspect of national resources, including soil, water, minerals, timber, waterways and even manpower. There can be nothing but approval of this

[1] Address on Commemoration Day at the Johns Hopkins University, February 22, 1937, celebrating the twenty-fifth anniversary of the founding of the School of Engineering at the Johns Hopkins University.

crystallization of effort to survey our situation with regard to natural resources for the purpose of developing a program which will conserve and use them for the best ultimate public interest. It is another step in that succession of moves in the same direction which have occurred since the time when this country first realized that its natural resources were not unlimited and must, therefore, be husbanded and used with wisdom.

Among the specific activities which have been undertaken under this general heading and which are in various stages of completion are the large number of construction projects under the Public Works Administration and related agencies, together with some special services in other bureaus. They range all the way from the St. Lawrence Waterway Project, which has not been authorized and remains in the controversial stage as to its economic desirability, to the work of the Tennessee Valley Authority, which is in an advanced stage of operation. Other such activities are the Soil Erosion Service, the Shelter Belt, the Mississippi Valley Commission, the Passamaquoddy Tidal Project, Grand Coulee and Bonneville Dams, oil production control, and so forth.

As scientists and engineers, our reactions to these various projects are probably diverse. At the bottom of the list in merit I would place the Shelter Belt, which was a grand emotional gesture, but whose conception in large part neglected essential scientific facts both of ecology and of aerodynamics. Somewhat higher in the list would be the Passamaquoddy Project, of undoubted engineering interest but economically unjustified. The Tennessee Valley Authority Project is undoubtedly accomplishing much of public value and will be a useful experiment, provided its results will be interpreted in accordance with the facts, as the engineer would objectively analyze them, and are not misrepresented for the political purposes of justifying past actions or of promoting future policies. Unfortunately, the records already contain some evidence that such abuse of the truth for ulterior purposes has already been practiced in this otherwise great engineering venture. Of highest value in the list I should place the Soil Erosion Service and the Oil Production Control, since a wise prosecution of the former will undoubtedly be of enormous ultimate benefit to our agriculture, and the administration of the latter is in aid of conservation of our oil reserves through elimination of some of the economic pressure to wasteful production.

Note the significant fact that nearly every aspect of this program of conservation of natural resources is an engineering job. I venture to suggest that the country may soon be in a position to draw a very important lesson in regard to the projects of the type which I have mentioned. Every one of them is interesting and is aimed at some valuable goal. From all the work which will be done on them, there will undoubtedly emerge much constructive improvement of the physical plant of our country. The great question to be answered, however, is whether the economic and social results of this great program have justified the expense; or, in other words, has the program been efficiently conceived and carried through? When these questions are examined, the criterion will be the analysis of the engineer; and I suspect that the answer will contain the conclusion that it will always be very much to the best interests of the country to have the decisions as to such programs made with more attention to the judgment of the engineer than has in the past been true.

Another important aspect of the rôle of the engineer in the conservation of our natural resources is well illustrated in the case of petroleum. For years there have been various estimates of the time in which our oil reserves will be exhausted. With every passing year we know more about the amount of oil which is still in the ground because of the continual surveys by improved methods to locate new oil fields. Consequently, it is safe to say that the present estimates are the most accurate which we have ever had.

In the recent annual report to the stockholders of one of the great oil companies, a company whose traditional policy has been to deprecate fear of early oil exhaustion, it was stated that the oil in sight in this country is sufficient to supply the present rate of demand for a little over twelve years. How much new oil may be discovered before this twelve years are past no one can foretell, but I believe that all experts now agree that the oil supply in the United States will begin to show shortage well within our lifetime.

Oil has become so important in the economy of the country that it is of tremendous importance to find some substitute fuel before oil becomes scarce. What the best substitute fuel will be is a question for the scientist and the research engineer to answer. Perhaps the two most promising fuels in sight are alcohol from agricultural products or hydrocarbons produced by hydrogenation of coal. For the public interest it is very important for the engineer to develop such fuels and to design engines adaptable to these different fuels in order that this important problem of fuels for automotive engines may be well solved by the time the need is pressing.

So we see that the engineer is involved in important ways both in the direct conservation of natural resources and also in the provision for the country's needs when these resources shall have been exhausted.

HOUSING

There seems to be general agreement that a notable improvement in the social conditions of the country

will come through a great housing program. Statistics show a real pressure for new homes. Sociologists and economists can easily demonstrate the great advantages in moral, spiritual and physical welfare which would follow a housing program wisely administered. There is no other work project which would give such a good distribution of employment and stimulation of industry, since it includes the heavy industries, equipment industries, transportation, skilled labor in the building trade and unskilled labor. The Federal Government, through its Federal Housing Administration, has exerted strong efforts to get a large housing program under way. Something has been accomplished, but on the whole the program has been disappointingly slow and ineffective. Nevertheless, I think there are few people who have studied the situation who do not believe firmly in the social advantage and the inevitable approach of a great program along these lines.

Fundamentally there are two aspects to the housing program on which its success will depend. The one involves the town or city planner and the other involves the engineer, although these two functions can not be entirely separated. The city planner must view with the eyes of a sociologist, a welfare worker, an economist, an engineer, a politician and a prophet those circumstances which determine where people should live, where people can live and what will be the future trends. He must consider such trends as the exodus of industry from the north to the south, or the east to the west, or the crowded city to the suburban community; he must make a practical estimate of how much the community will be willing to pay in the form of subsidy in rebuilding a slum district because of civic pride or humanitarian instincts, combined with the saving which will be secured in the administration of public health and law. This relatively new profession of the city planner is one in which the engineer, the architect and the sociologist all play cooperating rôles.

But in the last analysis the question of building houses or not building houses is an economic one and depends on the answer to the question: Can the houses be built of such a type and for such a price that they can be sold or rented at a reasonable profit? The answer to this question is definitely in the hands of the engineer, for it is the success of his work which determines the materials which will be used for construction, the methods employed in erection and the nature of the supplementary services of heating, ventilating, gas, electricity and plumbing. In private home construction there has been surprisingly little change in fundamental materials or methods since the earliest days, and there is strong reason for believing that ways will be developed for introducing into home construction some of the features which have made it possible for the ordinary man to buy, for $500 or $600, an automobile which, according to ordinary standards of excellence, ought to sell for several thousand dollars. If the engineer can make progress along these lines in the field of housing, then there is no doubt but that the flood gates will be opened and this country will see a tremendous boom in building construction.

This program is not an easy one, for there are many difficulties to be overcome. One is the inertia of habit and tradition which holds us to a certain notion of how and where people should live, even though this notion is indefensible by the logic of the present situation. Another difficulty may be with organized labor, which is so strongly entrenched in the building trades as perhaps to form a powerful obstacle to the introduction of any method of building construction which would partake more of the nature of erection than of traditional building. But most important of all is the fact that satisfactory success has not yet been attained in the search for materials and methods which will provide an entirely satisfactory house, one which does not look cheap, which will actually stand the wear and tear, which is solid enough to give the desirable feeling of security and privacy and which can be built more conveniently than the present home but at a notably lower cost. Here is undoubtedly a great challenge for the engineer.

Distribution

Another element in the American program for social progress is the search for more efficient methods of distribution of the products of agriculture and industry. This is not a problem which has been notably stressed during the emergencies of the late depression, but it is one of which the American people have been conscious for many years. Its significance is brought out by a comparison of the price paid by the consumer for his foodstuffs or home equipment or clothing as over against the price which is received by the farmer or the manufacturer who produces these articles. Such comparisons show that the cost of distribution is generally a major portion of the price which we pay.

The answer to this problem has not been found, although progress has been made. For example, the federal coordinator of transportation has urged increased efficiency in distribution over the railroads through consolidation and better planning of terminal facilities. The great increase in number and popularity of chain stores for distribution of household necessities and the success of the large mail-order houses are due to their contribution toward the solution of this great problem. Perhaps the most basic feature for securing the best possible solution to this problem is the maintenance of free competition, so that the man or the company who can discover a method of cutting the

costs of distribution will be financially rewarded for his efforts. Government assumption of the rôle of distributor would probably be the worst solution. If industrial codes should ever again be established, one important consideration is that they should leave the way open for the stimulation and encouragement to increased efficiency through some financial advantage to any organization which can find a means of reducing the cost of products to the consuming public.

There are many ways in which the engineer can contribute to this problem. One of these, of course, is through increasing the efficiency of the means of transportation by rail, highway and air. Another is through improvement in the methods of packaging and the discovery of large-scale methods for preserving perishable goods. Still another is in the development of methods for easy storage and for quick handling of goods. Thus there is scope not only for the "Simon pure" engineer, mechanical and electrical, for example, but also for the so-called efficiency engineer who operates by somewhat the same methods of logic.

Higher Standards of Living

And now I come to the last feature which I will discuss in the American program for social progress, and it is the one which is probably most prominently now in the minds of the American public. It is the effort to secure higher wages, shorter hours of labor and a generally higher standard of living.

When we consider wages, hours and standard of living, we find on analysis that there are two approaches to the desired objective in these matters. The one approach is through distribution and the other through creation. The former is a matter of legislation and negotiation, while the latter is primarily the responsibility of the engineer.

Let me illustrate this analysis by considering wages. Every worker desires the highest possible wage which he can secure. This is perfectly natural. The easiest and most direct way for him to get this is to try to take it away from some one else. This is the traditional method, which goes back to the dawn of history and has been the basic philosophy of wars, conquests, strikes and demagoguery in politics. On humanitarian grounds there has been much to defend this philosophy, because, also from time immemorial, we have had the picture of the strong oppressing the weak and the rich becoming richer at the expense of the poor. It is undoubtedly good and proper social philosophy and for the ultimate best interests of the human race that profit and wealth be distributed more evenly than has been the general tendency of the past.

A closer analysis of the situation, however, discloses the fact that there are definite limits and decided dangers in carrying this policy too far. The limits are disclosed by a survey of the amount of wealth or the amount of profit which is available for distribution. Thus it is found that the total amount of wealth or the total amount of profit, if distributed uniformly over the population, would raise the wealth or the income of the mass of workers by a disappointingly small amount. Furthermore, there would be a great danger in carrying this tendency too far, because to do so would dry up those sources of financial support which have proved to be the most potent means of creating new industry, providing new jobs and new profit. An extreme state of socialization involving more or less uniform distribution of wealth would certainly become very rapidly a state of stagnation in so far as progress is concerned and might very well become a state of retrogression.

This tendency of a movement toward a desired objective to set in motion forces which tend to counteract that objective is a social analogy of a well-known law of thermodynamics (Clapeyron) according to which any action sets up forces which tend to counteract it.

Therefore, while we can say that while a certain degree of distribution of wealth and profit is in the best public interest and is proper on ethical, economic and humanitarian grounds, nevertheless this approach to higher wages has its definite limitations and, if carried too far, brings serious dangers. Consider, therefore, the alternative of creating higher wages through the creation of new wealth by engineering methods.

Engineering methods in industry tend to raise wages by creation of new wealth in two different ways. One of these, which is the most direct and easily understood, is the development of new industries which directly provide new products, new employment and new profits. These industries depend upon inventive and engineering skill of a creative type. The other method is less direct and is sometimes misunderstood, as it was in the discussions of technocracy a few years ago. This indirect method operates as follows.

One function of the engineer is to discover the most convenient and economical method of doing the things which are desired to be done. Thus he creates labor-saving and quantity production devices whose first effect may be to throw people out of work through producing a given amount of goods with less labor. It is general experience, however, that this method of production so lowers the cost of goods that the market for the goods is enormously increased and the net result is far more labor at higher wages and with more profit than would have been possible without the introduction of the labor-saving and quantity production machinery. The assembly line in the automobile factory has not only made the automobile available to every class of person in the country, but it has resulted in creating one of the two or three largest lines of employment in

the country at next to the highest wage paid in any large industry. Similarly, it was the introduction of machine methods of building incandescent lamps that made these lamps so cheap that they have become universal lighting fixtures, providing again large employment in manufacture and distribution at a relatively high wage-scale.

Along with these higher wages there have come shorter hours of labor, which would never in the world have been possible except by the development of quantity producing machinery, which has enabled the human race to supply its necessities and its luxuries in a sufficiently short working day to leave time for education, recreation, old-age pensions and other advantages which are only possible to the extent that engineering developments increase productive power.

The ideal community, therefore, which we might call the "analogue of Plato's republic" expressed in terms of modern technique, would be a community in which all work is performed as easily and quickly as possible, and in which there are enough things to contribute to desires beyond the bare necessities of life to provide a proper amount of general employment. In this ideal community the increased profits due to engineering efficiency would be split three ways: between the wage-earner, the owner and the consumer.

In these days of agitation for higher wages and shorter hours and a higher standard of living, it is important to remember the fundamental fact that it is only efficiency of production through engineering methods which makes general improvement in these lines possible.

Having thus discussed the rôle of the engineer with reference to some of the best recognized elements in the American program for social progress, let me turn briefly to the consideration of another problem which is fundamentally related to these and to all activities in our national life. I refer to the problem of leadership.

It is a rather discouraging and frequently startling situation in which we so often have to admit that proper leadership is lacking and is apparently unavailable. One could very well take the ground, therefore, that in all the elements of the American program for social progress there is fundamentally involved the problem of developing leaders. What contribution does the field of engineering make to the solution of this human problem?

I can suggest an answer to this question quite briefly and very definitely by quoting from statistics which have been gathered by the director of the General Motors Institute, Mr. Robert H. Spahr, in connection with a report three or four years ago to the Society for the Promotion of Engineering Education. This survey of the officers of companies in American industry showed the startling fact that graduates of engineering or technical colleges are many times more likely to be found in positions of authority than are graduates of other types of colleges or non-college men. For example, out of the 235 college-trained presidents in leading American industries, 151 were trained in engineering or technical colleges, and 84 in colleges of all other types. When we consider the fact that the number of graduates of other types of colleges is many times greater than from the engineering colleges, these figures are even more striking, for they indicate that the probability of an engineering-trained man becoming president of an American industrial organization is 10 or 20 times as great as the same probability for a man of different college training. When we consider 54,000 officers of all types in finance, production, engineering and sales, we find an even stronger predominance of engineering-trained men, to such a extent that we can say that the probability of an engineering-trained graduate becoming an officer in an American industrial organization is from 25 to 50 times greater than this probability for a man of different college training.

These figures are a striking refutation of the wishful thinking back of the old saw, which goes, "You will always find the graduate of an engineering school working, but you will always find him working for some one else." Probably many of you have heard this statement with reference to the graduates of your own local institution.

By way of summary, therefore, of this whole survey of the American program for social progress, I think we can reduce the argument to two very simple and direct statements of fact. One is that the engineer, through the very nature of his experience and field of interest, has a most important position in bringing to accomplishment the various elements of this great program. A second is that experience shows that the engineering type of training is an unusually excellent training for responsible position in American industry.

With these statements of fact in mind, the conclusions as to our policy in regard to the rôle of engineers in this program for social progress are quite clear. Engineers should be given a more important rôle in the determination of national policies directed toward this program. They should be given the encouragement and stimulation which will lead to their best performance in achieving many of these objectives. Their environment, whether in government or industry or educational institution, should be made conducive to productive effort. And those of us who have a responsibility for engineering education in this country should take fresh courage from realization of the fundamental importance of our task and conviction that such contributions as we and our institutions can make are of such public value as to justify our best efforts.

OBITUARY

BOHUMIL SHIMEK

PROFESSOR BOHUMIL SHIMEK, member of the University of Iowa botany staff for the last 46 years, died at Iowa City, Iowa, on January 30, 1937, aged 75 years. His death was caused by heart complications following influenza. At the time of his death he was the second oldest member of the university staff. His name and work were inseparably linked with that of his noted naturalist colleagues, Thomas Huston Macbride, Charles C. Nutting and Samuel Calvin.

Professor Shimek was born in Shueyville, Iowa, on June 25, 1861, the son of Maria Theresa and Francis Joseph Shimek, political refugees who had immigrated to America from Bohemia in 1848. Professor Shimek's youth and education were closely bound up with the University of Iowa, which he entered in 1878 as a student of engineering. After attaining the C.E. degree, Professor Shimek was a railroad and county surveyor for two years. This early training and experience as an engineer resulted in unusual precision and exactitude in his later work in biology. In 1888 he accepted an instructorship in zoology at the University of Nebraska but returned to his alma mater in 1890 as a member of the botany staff. Professor Shimek's academic rise was rapid, as he soon became professor of botany, head of the department of botany, director of the Lakeside Laboratory, curator of the herbarium and later research professor. The high esteem in which Professor Shimek was held personally and as an educator was attested by the testimonial celebration tendered him by the university and the state of Iowa at the time of his retirement in 1932, at which time he had completed a fifty-year teaching career. The university in publishing his biography recognized his outstanding services as a pioneer, engineer, geologist, zoologist, conservationist, educator, patriot and citizen.

The chronicle of his life is unique both in the annals of the university and in the realm of natural science. Professor Shimek as a zoologist found his chief interest in the study of snails, and from his original interest along these lines developed his well-known work on fossil forms for which he has long been recognized throughout the world. His study of fossil malacology gradually developed into a broad interest in the Pleistocene geology of Iowa. He published a number of papers on loess and its fossils, and he is the author of the term "Nebraskan" applied to the till sheet which underlies the Aftonian interglacial deposits. Many of Professor Shimek's highest honors came in recognition of his geological work. He was a member of the Iowa State Geological Board and in 1911 was chairman of the Geological Section and vice-president of the American Association for the Advancement of Science, and in 1914 he was made honorary chairman of the Geological Section of the International Scientific Congress held in Europe as a tribute to his important contributions. The Geological Society of America had awarded him a research grant in 1936.

Professor Shimek's botanical contributions were in the field of ecology in relation to prairies. He strongly championed the concept that prairies were definite associations of species with common tolerance of intense light and rapid evaporation and that their treelessness was attributable to the high summer temperatures and drying winds. His notes comprise over fifty years of meticulous, quantitative observations which have followed the transitions of Iowa and surrounding prairies from pioneer times to the year of his death. He was at work in his office a few days before his final illness overtook him, studying herbarium material and completing a report on the plant geography of Iowa. Few scholars were as able as Professor Shimek to knit together vividly and accurately the whole story of natural history. His was a life spent largely out-of-doors in direct contact with the things about which he wrote. He was known for his insistence upon study in the field and the synthesis of the entire natural environment. In 1901 Professor Shimek took his first class of students to Lake Okoboji, where in 1909 the Lakeside Laboratory was established.

Professor Shimek labored ardently in behalf of the independence of Czechoslovakia in 1918, and with his personal friend, Thomas G. Masaryk, the historian, he planned during the latter's exile in America much of the strategy which finally resulted in Czech independence and Masaryk's election as the first president of Czechoslovakia. As president of the Czechoslovakian Council of Higher Education from its very inception he contributed greatly to the establishment of American standards and ideals of higher learning in the now independent nation of his forbears. He was called to the Charles University of Prague, Bohemia, as exchange professor in botany in 1914 and was awarded the Ph.D. degree in recognition of his scientific contributions. In recognition of his patriotic services he was awarded a special Czech medal of honor in 1927. His services to the state and education were memorialized by the Iowa legislature in a unanimous resolution of tribute passed on February 1, 1937.

Professor Shimek was long a leader in the educational development of the Middle West. He served as a member of several school boards and other education organizations. He was president of the Iowa Academy of Science in 1904 and later president of the Iowa Society of Engineers. He was a member of the

Botanical Society of America, Ecological Society, Washington and Iowa Academies of Science, Sigma Xi, national and state president of the Izaak Walton League, fellow of the American Association for the Advancement of Science, Geological Society of America, Botanical Society of Bohemia and Natural History Society of Prague. His passing is an irretrievable academic and civic loss to the state. He was the last of the elder statesmen of natural history in the Middle West.

W. F. LOEHWING

WESLEY M. COATES

THE sudden death of Dr. Wesley M. Coates has greatly shocked his colleagues in the department of physics of Columbia University and the Crocker Institute. Dr. Coates's death was due to an accidental contact with the power lines of the million-volt x-ray machine at the Presbyterian Hospital. The x-ray machine was not running at the time, but certain adjustments were being made on the oscillators which feed the x-ray apparatus preparatory to its use on the following day, and the presumption is that Dr. Coates slipped and accidentally came in contact with a power circuit of about 5,000 volts. His death was presumably instantaneous, for, despite every effort by his colleague, Dr. Exner, and the staff of the Presbyterian Hospital, he could not be revived.

He had received his academic training under Professor E. O. Lawrence and David H. Sloan at the University of California and a doctorate in physics in addition. He then worked with Professor Bergen Davis in the department of physics at Columbia University for two years, and for the past year has been active with Dr. Frank M. Exner, of the Crocker Institute, in putting the finishing touches on the x-ray machine belonging to the Crocker Institute, but housed by the Presbyterian Hospital. He and Dr. Exner and Professor Charles Packard had under way a large series of experiments in the field of biophysics. Dr. Coates was a man of excellent training, had a mind of very original type, and was an enthusiastic worker. He will be greatly missed by those with whom he worked.

F. C. W.

RECENT DEATHS

DR. GEORGE H. SHERWOOD, curator-in-chief of education and honorary director of the American Museum of Natural History, New York City, died suddenly on March 19 at the age of sixty-one years.

DR. JAMES B. OVERTON, professor of plant physiology at the University of Wisconsin, died suddenly on March 18. He was sixty-seven years old.

DR. RAYMOND R. HITCHCOCK, since 1914 head of the department of mathematics of the University of North Dakota, died on March 10. He was fifty-six years old.

ROBERT WALPOLE ELLIS, professor of geology at the University of New Mexico for nineteen years and state geologist of New Mexico from 1918 to 1927, died on March 10 at the age of sixty-eight years.

DR. LOUIS BEAUFORT, for thirty years professor of surveying and geodesy at the University of Toronto until his retirement in 1931 with the title emeritus, died on March 17 at the age of seventy-six years.

DR. JOHN F. MACKEY, director of industrial work in the department of chemistry at the Central Technical School, Toronto, died on March 11 at the age of fifty-one years.

SCIENTIFIC EVENTS

THE FIELD MUSEUM OF NATURAL HISTORY

FOR the tenth successive time, annual attendance at the Field Museum of Natural History in 1936 exceeded one million visitors. The total number of visitors in the year was approximately 1,180,000. More than 94 per cent. were admitted free. Only about 67,000, or less than 6 per cent., paid the 25-cent admission charge required on certain days. Admission is free to the general public on Thursdays, Saturdays and Sundays; children, students, teachers and members of the museum are admitted free on all days.

During the school year, Chicago's 500,000 school children were kept in daily contact with the museum by means of some 1,300 traveling natural history exhibits which are circulated among the schools on regular schedule by the N. W. Harris Public School Extension department of the museum.

In the spring and autumn the annual courses of free illustrated lectures for adults were presented in the James Simpson Theater of the museum. These, and the series of free motion-picture programs for children, extension lectures in the schools, guide-lecture tours at the museum and other activities carried on by the division of the museum known as the James Nelson and Anna Louise Raymond Foundation, reached approximately 250,000 persons.

Exhibits in all departments were augmented by new installations. In the department of zoology is a new habitat group of the rare emperor penguins, for which specimens collected by Rear-Admiral Richard E. Byrd on his last expedition to the Antarctic were presented to the museum by the Chicago Zoological Society. Another new group shows the grotesque gelada baboons found only in Ethiopia. Of interest is an exhibit of six different species of penguins from various parts of the world, the rare tamarao buffalo found only in the island of Mindoro in the Philippines, a specimen of

Derby's guan, a strange bird obtained in Guatemala by an expedition led by Leon Mandel, and examples of the little known four-horned antelope of India and the seldom seen Ethiopian ibex. Additions to the department of botany include a miniature model of a tea plantation of Ceylon and eight large mural paintings, by Staff Artist Charles A. Corwin, of landscapes in which are seen exotic trees and plants. The department of geology added to its exhibits the world's only mounted skeletons of the prehistoric Titanoides, and of the South American fossil mammal Homalodotherium; a group of various prehistoric animals trapped in the Rancho La Brea "Tar Pools" near Los Angeles and a cut-away model of the earth illustrating its internal structure in accordance with accepted scientific theories. Additions and improvements were made also in various exhibits of the department of anthropology.

As for several years past, financial conditions prevented the carrying out of expeditions, which were formerly such a large item in the museum's activities. However, through the interest of various individuals, the museum was enabled to acquire some material from field work.

EXHIBIT OF SCIENTIFIC PHOTOGRAPHY

IN Rochester from March 15 to April 3 there is being held what it is planned to be the most comprehensive and the largest exhibition of technological photography hitherto assembled.

It emphasizes photography in which pictorial or artistic quality is not the prime consideration and which is intended to convey information rather than emotional gratification or amusement. In addition the exhibition includes the largest collection of color photography ever shown publicly in the United States.

The exhibition has been arranged by the Rochester Technical Section of the Photographic Society of America. It is entitled the first International Exhibit of Scientific and Applied Photography. It will be on view in Rochester, where it is assembled, for three weeks; then it will move to certain large cities including New York, Chicago, Philadelphia, Kansas City and the West Coast. There will be no prize awards. There is no intention to advertise any particular make of photographic goods.

Over 1,500 photographs have already been received from the United States and many European countries. In addition to these the exhibition will include a group of 300 prints, collected for it by the Royal Photographic Society of England.

The emphasis is on scientific photography. The largest single section is that on medical photography. Another large and complete section is that on photomicrography.

Below are enumerated some of the exhibits to be shown:

The moon photographed on a glass sphere coated with emulsion.
Water spouts.
Aurora borealis photographs from the University of Oslo.
The very rarely seen anti-crepuscular rays.
Photographs, taken from 14¼ miles' altitude, showing actual curvature of the earth.
Complete history of the 1937 flood by the United States Army Air Corps.
Motions never seen by human eye taken at 1,000 pictures per second—including analysis of explosions in gasoline engines.
News pictures transmitted by various electrical means.
Fish building nests under water.
The life histories of the black widow spider and the malaria-carrying mosquito.
First photograph of the positron.
Plates carried to 20 miles' altitude in sounding balloons to record cosmic ray tracks.
Industrial x-ray photography.
Entire volumes of books photographed on short strips of motion picture film.
Photographs on gelatine sheets as were carried out of Paris by carrier pigeons during War of 1870.
Photomicrographs taken by streams of electrons rather than light rays, yielding magnifications of 6,600 times.
The highest magnification ever achieved showing resolution of lines one five-hundred-thousandth of an inch apart.
Time resolution of events occurring one ten-millionth of a second apart.
Color photographs of operations on the human brain.
Plastic surgery studies.
Facial studies of dementia praecox patients.
The arterial system of a human fetus.
The prenatal development of a rabbit from the one-celled stage to birth.
Amputations of arms and legs.
Recent cancer research.
Gallstone operation.
The interior of normal and abnormal human hearts and human eyes.
Moth larvae engaged in eating a woolen blanket.
The eggs of butterflies.
An original Daguerre camera, with daguerreotypes of famous personalities of a century ago.

THE WILDLIFE SOCIETY

FOLLOWING a year of existence as the Society of Wildlife Specialists, formal organization of the Wildlife Society was accomplished at a meeting at St. Louis, Mo., from February 27 to March 2. The society is primarily a professional group in which active members shall be those engaged in the practice of teaching of wildlife research, management or administration, or who are graduate students of those subjects. Associate members shall be those interested in the objects of the society who are sponsored by two active members. Some of the principal objectives of the Wildlife Society are the development of all types of wildlife man-

agement along sound biological lines, the establishment of professional solidarity among conservation biologists and the maintenance of the highest possible professional standards.

An official organ, *The Journal of Wildlife Management*, to contribute to these ends, will be launched in 1937, probably as a quarterly, under the editorship of W. L. McAtee, U. S. Biological Survey, Washington, D. C.

The governing body of the society for the year 1937, consisting of the officers and six regionally representative councilors, includes:

President, Rudolf Bennitt, associate professor of zoology, University of Missouri, Columbia, Mo.
Vice-president, Joseph S. Dixon, field naturalist, National Park Service, San Francisco, Calif.
Secretary, Victor H. Cahalane, assistant chief, Wildlife Division, National Park Service, Washington, D. C.
Treasurer, Warren W. Chase, regional biologist, Soil Conservation Service, Des Moines, Iowa.

Councilors:

For Region 1 (Northeast), Arthur A. Allen, professor of ornithology, Cornell University, Ithaca, N. Y.
For Region 2 (Southeast), William J. Howard, regional wildlife technician, National Park Service, Richmond, Va.
For Region 3 (North Central), Samuel A. Graham, professor of economic zoology, University of Michigan, Ann Arbor, Mich.
For Region 4 (Northern Great Plains), Verne E. Davison, regional biologist, Soil Conservation Service, Rapid City, S. Dak.
For Region 5 (Southwest) Walter P. Taylor, senior biologist, Bureau of Biological Survey, Texas A. and M. College, College Station, Texas.
For Region 6 (West), E. Lowell Sumner, Jr., regional wildlife technician, National Park Service, San Francisco, Calif.

The following advisory committee also has been named by the president:

Aldo Leopold, University of Wisconsin, Madison, Wis.
Herbert L. Stoddard, Thomasville, Ga.
Joseph Grinnell, University of California, Berkeley, Calif.
Ralph T. King, University of Minnesota, St. Paul, Minn. (past president).

THE VICE-PRESIDENT OF THE UNIVERSITY OF CALIFORNIA AT LOS ANGELES

DR. EARLE RAYMOND HEDRICK, professor of mathematics, was named vice-president and provost of the University of California at Los Angeles at a special meeting of the regents on March 10. The appointment was made on the recommendation of President Robert G. Sproul, the faculty at Los Angeles, the regents' committee of the University of California at Los Angeles and the Scripps Institution of Oceanography. The action of the regents was unanimous. Dr. Hedrick fills the vacancy caused by the retirement from administrative work on July 1 of Dr. Ernest Carroll Moore, now professor of education and philosophy at Los Angeles.

Dr. Hedrick was formally installed at the Charter Day exercises held on the Los Angeles campus on March 19. President Sproul presided at this meeting and made the formal installation. Dr. Hedrick delivered the annual Charter Day address in observance of the sixty-ninth anniversary of the founding of the University of California. He also spoke at the annual Charter Day dinner on March 23.

Dr. Hedrick, then of the University of Missouri, went to Los Angeles in 1924 as professor of mathematics and chairman of the department of mathematics. He was born at Union City, Indiana, on September 27, 1876. He received the degree of bachelor of arts from the University of Michigan in 1896, of master of arts from Harvard University in 1898 and of doctor of philosophy from the University of Göttingen in 1901. He was also a student at Ecole Normale Supérieure, Paris. The honorary degree of doctor of science was conferred on him by the University of Michigan in 1936.

Dr. Hedrick is a former president of the American Mathematical Society and of the Mathematical Association of America; he is a former vice-president of the American Association for the Advancement of Science, and is now secretary of the section of mathematics; he is a member of the American Society of Mechanical Engineers, of the American Institute of Electrical Engineers, of the Society for the Promotion of Engineering Education, of the National Education Association, of the Circolo Matematico di Palermo, Italy, and of the Société mathématique de France. He is also a member of the Council of Northern California Alumni of Phi Beta Kappa and of Sigma Xi.

Dr. Hedrick is a member of the American Engineering Standards Committee since 1927; a member of the Committee of the United Engineering Societies on Notation, and is chairman of the American Section of the International Commission on the Teaching of Mathematics. He has been editor of the *Bulletin* of the American Mathematical Society since 1921.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the International Symposium on Early Man, in celebration of the one hundred and twenty-fifth anniversary of the founding of the Academy of Natural Sciences of Philadelphia, the degree of doctor of science was conferred by the University of Pennsylvania on Dorothy Annie Elizabeth Garrod, of

Newnham College, Cambridge, director of the joint expedition of the British School of Archeology in Jerusalem and the American School of Prehistoric Research; on Dr. Vere Gordon Childe, professor of prehistoric archeology at the University of Edinburgh, and on Dr. Kaj Birket-Smith, director of the National Museum in Copenhagen.

THE Vega Gold Medal of the Royal Swedish Geographical Society has been awarded to Dr. Roy Chapman Andrews, director of the American Museum of Natural History, in recognition of his contributions to geographical and anthropological science. The formal presentation will be made on April 24, when the medal and the accompanying certificate will be given by Crown Prince Gustav Adolf of Sweden to Laurence A. Steinhardt, American minister to Sweden.

THE Hillebrand Prize for 1936 has been awarded by the Chemical Society of Washington to Dr. Vincent du Vigneaud, professor of biochemistry at the George Washington University Medical School. The award, which was presented to him on March 11, was made in recognition of his contributions to the chemistry of the biologically significant sulfur compounds and particularly for a paper on the synthesis of glutathione which was presented before the Chemical Society of Washington last October.

THE rank of Chevalier of the Legion of Honor has been conferred by the French Government on Dr. J. B. S. Haldane, professor of genetics at University College, London, in recognition of his scientific services to France.

TENNEY L. DAVIS, associate professor of organic chemistry at the Massachusetts Institute of Technology, has been elected a corresponding member of the Royal Society of Letters and Sciences of Bohemia.

AT a commemorative dinner held on March 12, Professor Albert Johannsen was honored by the department of geology of the University of Chicago on the occasion of his retirement from teaching. A portrait, the gift of Kappa Epsilon Pi, graduate geological fraternity, was unveiled, and Dr. Johannsen was presented with a bound volume of letters from former students and colleagues. Plans were also announced for issuing a special supplement to *The Journal of Geology,* in commemoration of the event. Professor Edson S. Bastin, chairman of the department of geology, presided at the dinner, and Professor R. T. Chamberlin delivered an informal commemorative address.

HORACE M. ALBRIGHT, formerly director of the National Park Service, has been elected president of the American Planning and Civic Association, which is active in the federal program of land and water conservation and development.

DR. CHARLES ROOT TURNER, dean of the Dental School of the University of Pennsylvania, was named president-elect of the American Association of Dental Schools at the recent convention in Baltimore.

THE following officers of the Royal Meteorological Society, London, have been elected: *President,* Dr. F. J. W. Whipple; *Treasurer,* W. M. Witchell; *Secretaries,* H. W. L. Absalom, W. Dunbar and E. L. Hawke; *Foreign Secretary,* J. F. Shipley; *New Members of Council,* Miss Ellen E. Austin and R. S. Read.

DR. LEWIS R. THOMPSON, assistant surgeon general, U. S. Public Health Service, has been made director of the National Institute of Health. From 1932 to 1934 he was a scientific director of the International Health Division of the Rockefeller Foundation and is now in charge of the division of scientific research of the Public Health Service.

DR. CHARLES MANNING CHILD, professor of zoology at the University of Chicago, has resigned after serving as a member of the faculty for forty-two years. Professor Child plans to live in Palo Alto and to continue his research work in the marine laboratories of Stanford University.

PROFESSOR LEE EDWARD TRAVIS has been appointed head of the department of psychology at the State University of Iowa to succeed Dean-Emeritus Carl E. Seashore on July 1. Professor Seashore will continue as research professor.

AT Columbia University, Professor Franz Schrader has been named head of the department of zoology, and Professor Joseph F. Ritt has become acting head of the department of mathematics.

DR. A. R. DAVIS, professor of plant physiology, has been named chairman of the department of botany of the University of California.

DR. ARTHUR G. NORMAN, of the Rothamsted Experimental Station, Harpenden, England, has been appointed professor of soil bacteriology in the department of agronomy of the Iowa State College and research professor of soil bacteriology in the Agricultural Experiment Station. Dr. Norman will go to Ames in September, filling the position formerly held by Dr. R. H. Walker.

DR. DANIEL J. POSIN, instructor in physics in the College of Pharmacy at the University of California, has accepted appointment as professor of physics at the University of Panama. He will sail for Panama in April.

DR. EDGAR DOUGLAS ADRIAN, fellow of Trinity College, has been elected to succeed Professor Sir Joseph Barcroft, fellow of King's College, in the chair of physiology at the University of Cambridge.

DR. JAMES GRAY, fellow of King's College and reader in experimental zoology in the University of Cambridge, has been elected to the professorship of zoology in succession to Professor J. Stanley Gardiner, fellow of Gonville and Caius College, who retires at the end of September, having occupied the chair of zoology since 1909.

DR. HERBERT LIGHTFOOT EASON, vice-chancellor of the University of London, was appointed on March 17 principal of the university, to succeed the late Sir Edwin Deller, who had held the position since 1929. Dr. Eason was superintendent and senior ophthalmic surgeon of Guy's Hospital and is a former dean of the medical school.

M. FRÉDÉRIC JOLIOT has been appointed professor of chemistry in the Collège de France.

FRANCIS HEMING, of the British Museum (Natural History), has been appointed secretary of the International Commission on Zoological Nomenclature. He succeeds Dr. Ch. Wardell Stiles, who has been secretary of the commission since 1896.

DR. JESSE E. HUNTER, associate professor in charge of poultry nutrition in the department of agricultural and biological chemistry at the Pennsylvania State College, has resigned to accept a position with Allied Mills, Inc., at Peoria, Ill.

M. CH. MAURIN has been named the successor of the late M. Hamy as member of the Bureau of Longitude, Paris.

STEPHEN L. TYLER, for more than twenty years chemical engineer in the American branch of the Thermal Syndicate, Ltd., has been made executive secretary of the American Institute of Chemical Engineers, effective on April 1. He will fill the unexpired term of Frederic J. LeMaistre, who recently resigned. The office of the institute will be moved from Philadelphia to New York.

DR. STILLMAN WRIGHT, limnologist of the Fish Commission of northeast Brazil, has returned from a three months' leave of absence in Argentina, where he made a preliminary survey of some lakes for the government. He will continue work on the artificial lakes of northeast Brazil, making his headquarters in Fortaleza, Ceara.

DR. ISAIAH BOWMAN, president of the Johns Hopkins University, will deliver the Founder's Day address at the University of Virginia on April 13, the anniversary of the birth of Thomas Jefferson.

DR. J. B. SUMNER, of Cornell University, addressed a joint meeting of the Toronto Chemical Association and the Toronto Biochemical Society on the evening of March 18. His subject was "The Enzyme Urease."

DR. VALY MENKIN, of the department of pathology of the Harvard Medical School, addressed the New York Pathological Society on February 25 on "Mechanisms of Inflammation."

DR. GEORGE H. PARKER, professor emeritus at Harvard University, gave the Mead-Swing Lecture at Oberlin College on March 12. His subject was "The Nature and Action of Neurohumors."

SIR HENRY DALE, director of the British National Institute for Medical Research, on May 18 will address the Academy of Medicine of Washington, D. C. He will speak on the chemical transmission of the nerve impulse from nerve to muscle.

THE American Association of Museums will meet at New Orleans on May 3, 4 and 5.

THE fifth annual meeting of the Society for Research on Meteorites will be held in conjunction with the one hundredth convention of the American Association for the Advancement of Science and its western Divisions at Denver, Colorado, on June 22 and 23. There will be two sessions a day, mainly for papers, one in the morning at ten o'clock and another in the afternoon at two o'clock. These sessions, which will be open to the public, will be held in the Colorado Museum of Natural History, the headquarters for the meeting.

APPLICATIONS for grants from the Cyrus M. Warren Fund of the American Academy of Arts and Sciences should be received by the chairman of the committee, Professor James F. Norris, the Massachusetts Institute of Technology, Cambridge, Mass., not later than May 1. Grants are made to assist research in the field of chemistry. On account of limited resources, grants to an individual are seldom made in excess of $300. The application should be accompanied by an account of the research to be undertaken, a statement of the sum requested and the manner in which the money is to be expended.

A SPECIAL summer school with conferences on the strength of materials will be held at the Massachusetts Institute of Technology for four weeks beginning on June 21. The subject of "Creep" will be presented by Dr. A. Nadai, consulting engineer of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, the last two lectures of this series being given by C. R. Soderberg, manager of the steam turbine department, Westinghouse Electric and Manufacturing Company. Lectures on fatigue will be given by Dr. H. J. Gouch, superintendent of the department of engineering of the National Physical Laboratory, England. Lectures on the strength of materials will be given by members of the institute staff. The laboratory exercises in the testing of metals will make

use of the more modern measuring instruments and apparatus. Four seminars will be held to afford opportunity for the presentation of recent developments in allied fields of engineering mechanics. The course will be concluded by two all-day conferences on "Fatigue and Creep," at which various aspects of these two subjects will be discussed.

ONE fourteenth of the total population of the United States, or 9,929,432 people, visited the 134 national parks and monuments in 1936, a gain of more than four million over 1935, and a gain of more than six million over the depression year 1931, when only 3,619,900 persons visited the areas. 1,772,338 people visited the parks in private cars during 1936 as against 1,217,054 in 1935. The newly established Shenandoah National Park, Virginia, dedicated on July 3, 1936, was visited by nearly 700,000 people; the Great Smoky Mountains National Park, on the border of North Carolina and Tennessee, by 602,222; Acadia National Park, Maine, by 340,393, and Mammoth Cave National Park, Kentucky, by 57,775. In the West, Rocky Mountain National Park, Colorado, reports 550,496 visitors; Yellowstone National Park, Wyoming, 432,570; Yosemite National Park, California, 431,192; Mount McKinley National Park, Alaska, 1,073.

A 2,200 acre wildlife refuge will be established by the U. S. Biological Survey in the Patuxent River valley section of Maryland. It has been named the Patuxent Research Refuge. The refuge, part of the National Agricultural Research Center of the Department of Agriculture at Beltsville, is about fifteen miles northeast of Washington. Wild turkeys, ruffed grouse, white-tailed deer, beavers, muskrat and other wildlife, once abundant in this section, are to be restocked on the refuge. Certain areas of the refuge will also be set apart for demonstrating wildlife management practices. On these tracts the Biological Survey will show how the latest facts found through research and experiment can be applied. Snowden Hall, an old-time southern mansion, is located on the refuge. It is to be reconditioned for the refuge headquarters, and other necessary buildings will be provided. A new laboratory building will be one story and basement. It will contain an office, three biological laboratory rooms, a room for housing wild birds and animals infected with disease, another for healthy animals and birds, and rooms for examining and storing specimens.

A PLAN to establish Pan-American postgraduate schools and hospitals in all the large cities of Central and South America was discussed recently, at a meeting of physicians at the Metropolitan Club, New York City, by Professor José Arcé, dean of the University of Buenos Aires. Professor Arcé, who is president of the Argentine Chapter of the Pan-American Medical Association, was the guest of honor at a dinner of the New York Chapter of the association. Speakers for the United States were Dr. Charles Gordon Heyd, president of the American Medical Association; Dr. James Ewing, of Memorial Hospital, and Dr. Dean Lewis, of the Johns Hopkins University. The plan announced by Professor Arcé is for the establishment throughout the republics of Central and South America of medical centers similar to the one proposed recently for New York City.

DISCUSSION

THE "PRIMARY CHANGE" IN ADRENAL INSUFFICIENCY[1]

IN his communication to SCIENCE entitled "The Significance of the Adrenals for Adaptation," Selye[2] makes the following statement. "It seems quite likely that the loss of sodium which is the basic change according to those who believe in the sodium deficiency theory (Loeb, *et al.*) or the increase in potassium (Zwemer) . . . all of which have been considered to be the primary change—are also symptoms rather than the cause of adrenal insufficiency." We have consistently avoided any expression which would suggest that we believe in a "sodium deficiency theory" or any other theory assigning a single function to the adrenal cortex. Furthermore, it is our opinion that the promulgation of any unitarian hypothesis concerning the function of the adrenal cortex tends, at this time, to inhibit the advance of physiological knowledge in this field.

It is indisputable that the regulatory effect of the adrenal cortex upon sodium metabolism is *one* of its important functions. The very fact that the single procedure of sodium withdrawal will induce acute adrenal insufficiency in the Addisonian patient[3] and the adrenalectomized dog is of obvious significance. Moreover, Harrop[4] has shown that totally adrenalectomized dogs will live for months without cortical extract if sodium salts are ingested in sufficient quantities.

On the other hand, we wish, in view of Selye's statement, to emphasize here, as we have in other publications, that the physiological activities of the adrenal cortex are varied and complex. In 1934,[5] we stated

[1] From the Department of Medicine, College of Physicians and Surgeons, Columbia University, and the Presbyterian Hospital, New York City.

[2] H. Selye, SCIENCE, 85: 247, 1937.

[3] R. F. Loeb, *Proc. Soc. Exp. Biol. Med.*, 30: 808, 1933.

[4] G. A. Harrop, L. J. Soffer, W. M. Nicholson and M. Strauss, *Jour. Exp. Med.*, 61: 839, 1935.

[5] R. F. Loeb and D. W. Atchley, *Med. Clin. of North America*, Vol. 17, New York Number, No. 5, 1317, 1934.

that "it should be emphasized that we do not assume that the regulation of salt balance is the sole function of the adrenal cortex." Furthermore, we have pointed out[6] that the adynamia, hypotension, hypoglycemia, pigmentation, gastro-intestinal symptoms and neurological disturbances of Addison's disease may occur without a decrease in sodium, and finally,[7] that "strength increases strikingly in the adrenalectomized dog following the administration of cortical extract before obvious changes occur in the blood urea or sodium concentration or in the water content of the blood serum."

ROBERT F. LOEB
DANA W. ATCHLEY

"MIGRATION" AND "HOMING" OF SALMON

BY derivation "migration" signifies "wandering." It has come to mean, especially in biology, a definite, purposive movement, preferably "en masse." The salmon is an outstanding example of the fishes that are supposed to show such movements. The Atlantic salmon (*Salmo salar*) spends a number of years as a parr in its natal river before transformation into the smolt stage. The latter is considered to make a feeding migration to the ocean and after several years when an adult a spawning migration back to its natal river. For their return "from the ocean" perhaps to "points far distant from their own rivers" and for their subsequent "travel along the coast" Calderwood[1] states "they find their way by a homing instinct which man can not comprehend."

On inquiry and examination of the literature I have failed to find a single clear case of a salmon returning to its natal river from a distant place in the sea, that is, away from the neighborhood of the river mouth. Admittedly this is a difficult thing to prove, since we must be sure of three things for the individual fish: (1) Which is its natal river? (2) where it has been in the sea, and (3) that it is again in its river. Perhaps some one may be able to produce such evidence. Without it, however, it seems pointless to speak of a "homing instinct."

The movements that have been definitely shown may be placed in three categories: (1) Fish marked as smolts or tagged as kelts in a certain river, being recaptured in that river after having left it, but not necessarily having gone from the neighborhood of the river mouth; (2) fish marked as smolts or tagged as kelts in a certain river being recaptured at a near or distant place in the sea or in another river; and (3) fish tagged in the sea and recaptured at another place in the sea or in a river. There may be mentioned for the Atlantic salmon Alm's[3] experiments in the Baltic, Dahl and Sømme's[4] for the Norwegian coast, those of Calderwood[5] and others for Scottish waters as well as the Canadian ones.[2, 6] There have been similar experiments with the Pacific salmons.[7]

In quite a number of instances salmon marked or tagged in one river have been recaptured in another, which constitutes definite evidence against homing. White[2] has shown that this may occur even when the fish is presented at a fork in a common estuary with a choice between another river and its own.

If the traditional conception of salmon migration falls to the ground for lack of definite proof and with clear evidence to the contrary, what is to replace it? The facts show that the salmon wanders to and fro in the sea and this may be considered a migration. Such slight evidence as we have and the analogy of the herring point to these excursions being made when the fish is not feeding. Their range seems to increase with the size of the fish[8] and also, it may be confidently affirmed, with rise in temperature from the winter low, which may be less than 0° C. When the salmon are within the zone of the river's influence at sea these excursions seem to be definitely controlled by a sufficiently steep gradient in the proportion of river water, so that the salmon tend to remain where the proportion is high, as shown by the distribution of the salmon in relation to the outflow of Saint John River water into the Bay of Fundy.[8] The Scottish River Tay similarly has a pronounced zone of influence at sea,[5] and the two rivers agree in that none of the salmon kelts tagged and liberated in them has ever been reported as recaptured in the sea outside the zone of influence or in another river.

It would seem that if a fish happens to get very far from this zone of river influence there is little likelihood that it will in its random wanderings reach the place where the marked gradient occurs. It may then be said to be "lost." Such salmon may reach neighboring rivers or travel very far in the sea. Though they wander to and fro, yet is their course in part determined by the movement of the water. As they tend to keep near the surface, it is not surprising to find that

6 R. F. Loeb, *Jour. Am. Med. Assn.*, 104: 2177, 1935.
7 J. Stahl, D. W. Atchley and R. F. Loeb, *Jour. Clin. Invest.*, 15: 41, 1936.
1 W. L. Calderwood, "A Survey of Salmon Fisheries in Eastern Canada," p. 4, 1930.
2 H. C. White, *Jour. Biol. Bd. Can.*, 2: 391–400, 1936.
3 Gunnar Alm, *Ny Svensk Fiskeritidskrift*, 1: 1–6, 1931.
4 K. Dahl and S. Sømme, *Skr. Norsk. Vid.-Ak. Oslo*, I. *Mat.-Nat.* Kl., 1935, No. 12.
5 W. L. Calderwood, "The Life of the Salmon," 1908.
6 A. G. Huntsman, *Bull. Biol. Bd. Can.* 21: 78–92, 1931.
7 W. H. Rich and H. B. Holmes, *Bull. U. S. Bur. Fisheries*, 44: 215–264, 1928; J. O. Snyder, *Calif. Fish Bull.*, 34: 67–81, 1931; "Pacific Salmon Migration," various articles by H. C. Williamson, C. McC. Mottley and others in *Contr. Canad. Biol. Fish.*: 3 and 4, and in *Bull. Biol. Bd. Can.*, 14, 15, 16, 26, 27, 31, 40, 41.
8 A. G. Huntsman, *Bull. Biol. Bd. Can.*, 51: 14–15, 1936.
9 Ann. Rep. Dept. Fisheries Can., 4, 5 and 6: 118, 130 and 130–131, 1934, 1935 and 1936.

to a considerable extent they go where drift bottles go. In Canadian Atlantic waters drift bottles mostly travel to the northeast in correspondence with the prevailing southwest winds of summer. From 1931 to 1934, 642 salmon kelts were tagged and liberated in the Nictaux River, a branch of the Annapolis River of western Nova Scotia. This river has a very weak influence where it empties through the Annapolis Basin and Digby Gut into the Bay of Fundy. Of the 24 salmon recaptured and reported,[9] five were taken at various points on the east coast of Newfoundland, a minimum distance by sea of about 900 miles and one at Ramah in northern Labrador, more than 1,000 miles farther and northward along the coast. The remainder were all taken in the river, except one at Yarmouth, N. S., which is on the route to Newfoundland. The drift bottles that take this course northeastward from the mouth of the Gulf of Maine have been found only as far as Sable Island on this side of the Atlantic. Most of them enter the North Atlantic drift, which carries them to the Azores and the European coast. The salmon, on the other hand, seem to keep to the waters with river ingredients, which extend little beyond the banks, and thus they ultimately reach some point on the coast.

A. G. HUNTSMAN

UNIVERSITY OF TORONTO

A WHALE SHARK IMPALED ON THE BOW OF A STEAMER NEAR THE TUAMOTUS, SOUTH SEAS

THROUGH the courtesy of Rear Admiral W. R. Gherardi, head of the Hydrographic Office of the U. S. Navy, I have learned of the interesting happening indicated in the title of this note. Through his kindness there was published in *Hydrographic Bulletin* No. 2362 a short description and a good figure of the whale shark (*Rhineodon typus*). This was done in the hope that the interest and help of ships' officers might be enlisted for the sending in of observations of the occurrence of this greatest of sharks. This hope has been abundantly realized. Information concerning the particular specimen in question comes from Mr. S. H. Crawford, third officer of R. M. S. *Maunganui* of the Union Steam Ship Company of New Zealand, Ltd.

On September 7, 1934, in Lat. 13° 59′ S. and Long. 147° 46′ W. (about 60 mi. N. N. E. of Tikehau Atoll in the Tuamotus) the *Maunganui* struck a large animal at first thought to be a whale. The vessel was steaming at about 16 knots and the animal was struck so sharply just behind the head that it was impaled on the stem of the ship. Here it was held so securely by the pressure of the water that the engines had to be reversed and the ship backed before the bows could be cleared of the great carcass.

While on the bow of the steamer, the head-to-gills region was estimated at about 15 feet and the remainder of the body at about 40 feet, making the total length about 55 feet. This could well have been, for in the Indian Ocean the fish has been measured to 45 feet, and in the Gulf of Siam estimated by an ichthyological friend of mine at 60 feet.

Recalling the figure of *Rhincodon* seen in the *Hydrographic Bulletin,* when Mr. Crawford noted the square-cut head and the speckled markings plainly visible, he recorded the fish as a whale shark. A photograph was taken of the fish held against the vessel's stem, and a copy of this through the good help of the Hydrographic Office was obtained from Captain Toten. This settled the matter once and for all that a second whale shark must be recorded from the Tuamotu Archipelago, South Seas.

In May, 1928, divers at work in Takeroa lagoon were confronted by a spotted shark about 17 feet long. They killed and skinned it. M. F. Hervé, administrator of the Tuamotus, sent the skin to the little museum at Papeete, Tahiti. M. Rougier, curator of this museum, made record of it in *Bulletin Société Études Océanographique,* Papeete, 1929, Vol. 3, 318–319.

It will interest the reader to know that this is the sixth recorded case of the spearing of a whale shark by a steamer making her way over the ocean. One case has been recorded from the Indian Ocean, two from the Red Sea and two from the Atlantic. I plan later to bring these accounts into an article.

E. W. GUDGER

THE AMERICAN MUSEUM OF NATURAL HISTORY

JELLYFISH FROM GRAND CANYON ALGONKIAN

THE impression of a medusa, commonly known as a jellyfish, was found during the summer of 1934 in a fine-grained sandstone of the Nankoweap group of the Grand Canyon series.[1] The Grand Canyon series lies upon the Archean complex and has been divided into the Unkar, Nankoweap and Chuar groups. The medusa measures 18 cm across and is thought to be a marine type. A paper giving the details of this specimen is now in preparation.

The writer examined the lower portion of the Algonkian rocks during 1933 and 1934 under a program sponsored by the Carnegie Institution of Washington, and was accompanied by R. A. Bramkamp when the medusa was found.

C. E. VAN GUNDY

UNIVERSITY OF CALIFORNIA BERKELEY

[1] C. E. Van Gundy, Abs. Program Cordilleran Section Geol. Soc. of America, April, 1936.

REPORTS

ACTIVITIES OF THE ENGINEERING FOUNDATION

THE scientific laboratories of fourteen universities are cooperating with the Engineering Foundation in an effort to solve technological and human problems in the fields of mechanical, electrical, mining and metallurgical and civil engineering, according to a report by the foundation.

Two government bureaus are aiding in special investigations. Working with other groups, the four founder societies, of which the foundation is a research agency, are advancing engineering education and professional development as well as personnel research.

Long-term projects sponsored by the foundation include alloys of iron research, comprising a review of world information on alloy steels and alloy cast irons; and welding research, embracing more than sixty fundamental studies in college and industrial laboratories and a compilation of welding literature.

Cottonseed processing research is being carried on in laboratory and field by a committee of the American Society of Mechanical Engineers with headquarters at the University of Tennessee.

World interest in earths and foundations has been aroused by a committee of the American Society of Civil Engineers, which has directed research in this sphere since 1929. A soil mechanics laboratory has been established at Harvard University. The lateral supporting power of soils to individual piles, anchors and bulkheads is being studied at Yale University. Models of earth dams and coffer-dams are furthering extensive investigations at the University of Minnesota.

Barodynamic research, the study of weighty masses by means of special centrifuges, is going forward at the School of Mines of Columbia University. Confirmation of laboratory results has been obtained from surface and underground observations of mining problems in Europe and Africa. A device for determining side pressures of loose materials and a new type of artificial support in mines have been developed. Stress distribution in mine pillars and roofs and the time effect in rock structures strained beyond elastic limits have been determined.

Designs for a new type of critical pressure steam boiler may grow out of a basic investigation at Purdue University by the Society of Mechanical Engineers. Determinations of viscosity of water and steam and reactions between steam metal at elevated temperatures have been studied particularly. At the University of Michigan, a boiler feed water research project is concerned with methods of determining oxygen in the waters.

The Non-Metallic Minerals Experiment Station of the U. S. Bureau of Mines in New Brunswick, N. J., is attacking the problem of embrittlement in boiler steel and expects to learn its cause and means of prevention.

A specially built machine at the Massachusetts Institute of Technology is testing the strength of gear teeth. Recent operations have been devoted to experiments with surface fatigue of cast iron.

A large piece of steel known as a "test log" is being cut at the University of Michigan in the course of an investigation of the efficiency of cutting fluids, that is, the fluids used for lubricating and cooling metal-cutting tools. A handbook on "Cutting of Metals" has recently been completed under direction of the American Society of Mechanical Engineers.

The National Bureau of Standards, Massachusetts Institute of Technology, Cornell University, the Universities of California, Ohio, Oklahoma and several industries are conducting experiments with long-radius flow nozzles, used in fluid meters, in order to provide more economical and convenient means for precise measurements of large quantities of liquids or gases, as in efficiency tests of steam and hydraulic power installations. In some instances steam is used, in others, water, through nozzles ranging from three inches to sixteen inches in diameter and also through two-inch pipe orifices.

Ten years of research on pure iron electrodes, sponsored by the American Institute of Electrical Engineers at Lehigh University, was recently completed. This phase of welding research will be merged in the comprehensive program of the foundation's welding research committee.

Information on the creep and relaxation of metals was gathered last year as part of a study of metal plasticity carried on at the University of Pittsburgh, with research facilities provided by the Westinghouse Research Laboratories. Special apparatuses were designed and constructed for the work, the results of which are proving of practical value.

Nearly 500 specimens of concrete are under observation in long-time tests at the University of California to determine the various factors in the plastic behavior of concrete. Three new series of investigations have been started, comprising studies of the moisture loss accompanying plastic flow under sustained load, of the validity of the assumption of plane bending in beams under sustained load, and of the effect of compound composition and fineness of cement upon plastic flow. Thermal stress studies have already been completed.

Through the Personnel Research Foundation, the Engineering Foundation is encouraging forms of em-

ployer-employe cooperation by visits to industrial plants, correspondence with governmental departments and labor organizations and by conferences.

Six thousand copies of "Self-Appraisal for Junior Engineers" were placed in the hands of engineering students last year by the Engineers' Council for Professional Development, composed of representatives of the national engineering societies and professional organizations. Nearly 5,000 copies of a booklet on "Engineering—A Career—A Culture" were distributed during the year.

The council, conducting an investigation on the accrediting of schools, sponsored visits to schools in New England and the Middle Atlantic States. The work is now being initiated in other states. The council is also directing studies on the evaluation of professional qualifications, guidance literature and aptitude tests. A selected reading list of books on general fields of knowledge for young engineers and a bibliography of technical literature have been prepared.

The council seeks uniformity in engineering degrees. Conferences are being arranged for boys interested in engineering, their parents and local engineering groups. A survey has been made of university extension facilities, and a manual on guidance for local sections of the national engineering societies is available.

SPECIAL ARTICLES

THE NEW DISCOVERY OF THREE SKULLS OF SINANTHROPUS PEKINENSIS

FOLLOWING the recovery of several fragments of a very small adult of *Sinanthropus* from Locus I (Locality 1) in the latter part of our spring field season at Choukoutien, we had the good fortune during the fall season of this year to unearth three additional more or less well-preserved skulls, two of which were recovered in one day. All three skulls belong to adult individuals. The skull recovered first, and designated as Skull I of Locus L, is the largest with a cranial capacity of approximately 1,200 cc and with its coronal and sagittal sutures partly fused. The second skull (Skull II of Locus L) is the smallest of the group, with a cranial capacity not higher than 1,050 cc and its coronal, sagittal and lambdoid sutures fused. This skull shows a clear indication of the persistence of a metopic suture. The third skull (Skull III of Locus L) is smaller than Skull I but larger than Skull II. The cranial capacity of Skull III is approximately 1,100 cc. Although all the sutures of this skull are still patent, yet other characteristic features make it evident that we are dealing with a young adult individual. Parts of the face are preserved in all three skulls, thus, in Skull III both nasal bones and the entire lateral border of the orbit in complete connection with the brain case; in Skull II the frontal process of the maxilla, the lower border of the orbit, the cheekbone and fragments of the alveolar process of the upper jaw with palate and ten teeth *in situ* (premolars and molars) which, however, are not connected with the skull. Belonging to Skull I are several teeth only.

I had previously arrived at the conclusion that the large teeth may belong to male individuals and the small to female individuals. This assumption has been confirmed by the fact that the large type of teeth was found to pertain to the bigger skull (Skull I) and the small type of teeth to the small skull (Skull II). Thus it seems quite certain that the latter represents the skull of a female individual and the former that of a male individual.

All three skulls have the same appearance as Skull I of Locus E described by Davidson Black.[1] However, since this skull belongs to a child of about 8 to 9 years (*cf.* Weidenreich, 1935)[2] the characteristics of the *Sinanthropus* type are much more pronounced in the recently recovered skulls. Measurements reveal that *Sinanthropus* as a whole occupies the lowest place in the order of all hominids, including *Pithecanthropus*, in regard to those peculiarities which determine its position in the line of evolution. This is particularly true for Skull II of Locus L, while Skull I of Locus L in part falls within the lower limits of the range of variations of the Neanderthal group. However, Skull II apparently is even lower than *Pithecanthropus*, the difference being that the *Sinanthropus* skull shows a more pronounced frontal tuber than *Pithecanthropus*, the entire forehead of which is flattened. The smallness and lowness of *Sinanthropus* Skull II is all the more remarkable since the skull fragments recovered last summer and considered to pertain to an adult individual are still smaller in dimensions than the respective parts of Skull II of Locus L and *Pithecanthropus* (*cf.* Weidenreich, 1937).[3]

As to the face, the parts preserved in Skulls II and III yield a rather good idea of the general structure, at least as far as the upper parts are concerned. The nasal bridge is broad and flat. There is no groove between the root of the nose and the forehead. The orbit is very low; the lateral border recedes backwards below the frontal zygomatic suture. The lacrimal fossa is missing in all skulls. The orbit is deep and the superior orbital fissure very small. The cheek bone is remarkably high, as high as that of the Rhodesia Skull. A canine fossa does not exist and the anterior surface of the frontal process of the maxilla

[1] Davidson Black, *Palaeontologia Sinica*, Ser. D, 7: 2, 1931.

[2] Franz Weidenreich, *Bull. Geol. Soc. China*, 14: 427–468, 1935.

[3] *Idem.*, *Bull. Geol. Soc. China*, Ting Memorial Volume (in press).

is slightly convex and not depressed, as in recent man. The upper jaw therefore must have projected considerably. The palate is broad and high.

Earlier (1935) I was able to demonstrate that a close connection between *Sinanthropus* and certain groups of the present Mongol race could be assumed. The occurrence of the so-called "torus mandibularis" on the inner side of the mandible of some of the *Sinanthropus* jaws as well as on those of recent Mongols, especially Eskimos and Lapps, and furthermore the occurrence of shovel-shaped medial and lateral upper incisors in *Sinanthropus*, as also in modern Mongols, indicate some direct relationship between Peking Man and the Mongol group of recent mankind. Whether or not the broad and flat nose of *Sinanthropus* points to the same direction I do as yet not venture to state. However, in addition there is another conspicuous feature which, I believe, serves as further evidence for the assumption of such a special relationship. All three adult skulls show a large "inca-bone" (*os epactale*) which, it is true, is not confined to the ancient Peruvian natives, as the name suggests, but also occurs in other races of to-day. However, it is much more frequent in the American Indian and Mongol group (up to 7.8 per cent.) than in the latter (up to 2 per cent.).

As to the relation to *Pithecanthropus*, *Sinanthropus* Skull II of Locus L, together with the fragmentary *Sinanthropus* of Locus I mentioned above, prove incontestably that there is no appreciable difference between *Pithecanthropus* and *Sinanthropus* as far as the general shape and the lowness of the skull caps are concerned. Since it has been assumed that these two *Sinanthropus* skulls belong to female individuals, it is very probable that *Pithecanthropus* also belongs to the same sex, a probability which had already been pointed out by E. Dubois and Hrdlička. The *Sinanthropus* skulls differ from *Pithecanthropus* by only two characters, namely, in that the frontal bone proper is more vaulted in *Sinanthropus*, although its inclination to the glabella-inion line is distinctly more pronounced than in *Pithecanthropus*. Furthermore, the supraorbital ridges of *Sinanthropus* are separated from the forehead by a really broad furrow, while in *Pithecanthropus* they continue gradually to the brow. The latter phenomenon, however, seems to have some connection with the formation of the frontal air-sinuses. In *Pithecanthropus* these sinuses are conspicuously large and extend far lateralward over the roof of the orbit, whereas in all cases of *Sinanthropus* they are very small and closely confined to the interorbital region. I consider this appearance in the case of *Sinanthropus* as an indication of its being more primitive than *Pithecanthropus* and the latter, in spite of the absence of prominent frontal tubera, as a more advanced type of hominid.

Another important fact is disclosed by *Sinanthropus* Skull I of Locus L. This skull is not only the largest of all *Sinanthropus* skulls recovered hitherto (*ca.* 1,200 cc) but at the same time also the highest. Although its general structure and essential details show the same characters as the lowest Skull II of Locus L, yet its greater cranial capacity approaches closely the more primitive representatives of the Neanderthal group. I had earlier (1936)[4] assumed that there must be some relation between *Pithecanthropus* and *Javanthropus soloensis*, the latter resembling the former in several primitive characters. On the other hand, there is no doubt that *Javanthropus* has many peculiarities in common with *Sinanthropus*, as recently demonstrated by C. U. Ariens Kappers (1936)[5] in regard to the endocasts. I should not be surprised if *Pithecanthropus* at some future date should be found to represent nothing else but a special female type of *Javanthropus*. Since *Javanthropus* as a whole represents a very primitive form of Neanderthal Man, the line linking *Pithecanthropus* and *Sinanthropus*, respectively through *Javanthropus* or Neanderthal Man to recent man is continuous. The fact that there may be certain racial deviations does not matter greatly, since the determining factor does not depend on relatively minute differences but on the main course of human development itself.

FRANZ WEIDENREICH
PEIPING UNION MEDICAL COLLEGE
AND CENOZOIC RESEARCH LABORATORY,
GEOLOGICAL SURVEY OF CHINA

EXCHANGES BETWEEN BLOOD PLASMA AND TISSUE FLUID IN MAN

IN previous publications[1] we have shown, with normal men, that brief violent exercise produces a sudden transudation of up to 20 per cent. of the plasma water from the blood to the tissues. The return of the volume and the general concentration of the blood to the resting level follows, approximately, a logarithmic deceleration curve and requires about an hour. In these exchanges the water is accompanied by a small amount of proteins which are highly active osmotically (*i.e.*, their molecular size is small). This does not mean that the capillaries are extraordinarily permeable. The plasma calcium, including the so-called "diffusible" fraction, does not escape across the capillary wall more readily than does protein under these conditions.

The behavior of the sodium concentration in experiments of this type (exhaustion produced in 1 minute) throws further light on the permeability of the capil-

[4] *Idem*, *Peking Nat. Hist. Bull.*, 10: 4, 281–290, 1936.
[5] C. U. Ariens Kappers, *Jour. Anat.*, 71: 61–76, 1936.
[1] Keys, *Jour. Biol. Chem.*, 105, xlvi, 1934; Keys and Taylor, 1935, *ibid.*, 109, 55; Keys and Adelson, *Amer. Jour. Physiol.*, 115: 539, 1936.

lary wall. In all cases (15 subjects) the sodium concentration in the plasma immediately after work is from 2 to 10 per cent. above the resting level, but the recovery is rapid. In 15 minutes $[Na]_S$ is very nearly at the resting level; at this time the return of water to the blood stream is only 60 to 75 per cent. complete. Apparently, the rate of exchange of sodium across the capillary wall is markedly less than that of water but is still very rapid in comparison with the readjustment of the blood volume.

The behavior of the plasma potassium is very different. Immediately at the end of work $[K]_S$ may be as much as 25 per cent. above the resting level, but it drops precipitously. After 10 or 15 minutes the level is from 5 to 15 per cent. *below* the resting level. $[K]_S$ then begins to rise and exceeds the resting level as much as 20 per cent. at 40 minutes; the resting level is regained in from 1 to 1½ hours. This remarkable cycle is consistently found (6 subjects); it is not due to hemolysis or exchanges with the red cells.

Intravenous injections of adrenalin (0.05 to 0.2 cc of 1 to 1,000 solution) produce a rise in blood pressure and a general hemoconcentration similar to the effect of brief exercise, but the response of $[K]_S$ is different. We have found no initial rise of $[K]_S$ resulting from adrenalin. $[K]_S$ decreases from 4 to 15 per cent. below the resting level within the first few minutes; thereafter $[K]_S$ rises, reaching from 5 to 15 per cent. above the resting level after about an hour.

The exchanges of Na, Ca, H_2O and protein are readily interpreted in terms of osmosis and different rates of diffusion through the capillary walls. From preliminary results this seems also to be true of sulfate and Cl. Such explanations are totally inadequate to account for the potassium exchanges. It may be noted that it is possible the secondary fall and subsequent rise of $[K]_S$ beginning about 8 minutes after exercise may be entirely analogous to the changes in $[K]_S$ following adrenalin; in fact, these delayed effects may be due to a delayed production of adrenalin. However, such a theory would not account for the adrenalin effect itself nor would it throw any light on the immediate effect of exercise on the $[K]_S$.

These results were obtained from duplicate, triplicate and quadruplicate analyses, which agreed within about ± 1 per cent. These experiments will be published *in extenso* in the near future. The potassium method will be published separately.

ANCEL KEYS

THE MAYO FOUNDATION
ROCHESTER, MINN.

THE PLANT ORIGIN OF A VITAMIN D

IN the animal kingdom the vitamin D group is widely distributed, but only in the fishes has it so far been found in great concentration. To account for this, Steenbock and Black[1] suggested that the vitamin might originate from the solar irradiation of plankton. Attempts to support this hypothesis have so far been consistently negative in phytoplankton,[2,3] although results of doubtful significance have been reported with zooplankton.[4,5]

Spectrographic studies[6] on the presence of ultraviolet light below the surface of the sea, made at the Tortugas Islands where the water is very clear, have shown a high intensity of relatively short wave-lengths in the first three feet. In the light of these findings, the Sargassum weed seemed a logical form to investigate for the presence of vitamin D. This alga grows at shallow depths in the clear waters of the Caribbean. Although there is doubt as to whether some forms originate at the bottom and later lose their attachments, all species float and grow on the surface for some months, small sprigs at times protruding as much as 10 cm above the water.

We therefore tested the lipin fractions of *Sargassum* for antirachitic properties. Samples collected in the Gulf Stream off Cape Hatteras during May and off the Tortugas during July have yielded oils (in amounts corresponding to 2.5 and 3.0 per cent., respectively, of the dry material) which are definitely curative for rickets. The Sargassum from the Tortugas, after several washings in fresh water to remove accompanying animal forms, furnished a lipoidal mixture which was active in rat-doses of less than 3 mg divided over 8 days. Oils from *Ulva* and *Laminaria* collected off Cape Cod during August were inactive at much higher dosage levels. More exhaustive assays are in progress, and the determination of the rat-chicken activity ratio is planned.

The product from the Hatteras collection of *Sargassum* has been subjected to chemical examination. The unsaponifiable fraction, amounting to 28 per cent. of the oil, yielded about 20 per cent. of a colorless crystalline sterol apparently identical with the fucosterol isolated by Heilbron *et al.*[7] from *Fucus vesiculosus*. This sterol, which was purified by crystallization only, without the use of charcoal, exhibits no selective absorption in the ultra-violet region, and therefore[8] contains neither a vitamin nor a provitamin of the D

1 Steenbock and Black, *Jour. Biol. Chem.*, 64: 263, 1925.
2 Leigh-Clare, *Biochem. Jour.*, 21: 368, 1927.
3 Drummond and Gunther, *Nature*, 126: 398, 1930; *Jour. Exp. Biol.*, 11: 203, 1934.
4 Belloc, Fabre and Simonnet, *Compt. Rend.*, 191: 160, 1930.
5 Copping, *Biochem. Jour.*, 28: 1516, 1934.
6 Darby, Johnson and Barnes, Papers from the Tortugas Laboratory, in press.
7 Heilbron, Phipers and Wright, *Jour. Chem. Soc.*, 1934: 1572.
8 Gillam and Heilbron, *Biochem. Jour.*, 30: 1253, 1936.

group. Such a substance, however, is present in non-crystalline fractions, which display a distinct absorption band at 260 mμ superimposed upon the absorption of carotenoids and other accompanying substances.

Sargassum collected at its site of origin is relatively free from closely associated foreign organisms, even protozoa, and the "leaves" are clear and intact. However, a fairly large colony of free-swimming shrimps and fishes is present. Much of the weed finds its way into the Gulf Stream, and during its northward passage becomes heavily infested with invertebrates. Samples taken north of Hatteras present a complex picture of plant and animal commensalism: the stems are covered with masses of the long-necked barnacle (*Lepas*) and immense numbers of mollusks with their eggs. Several types of shrimps and fishes abound. The "leaves" are now extensively damaged and often completely missing.

Little imagination is needed to visualize the progressive transfer of the vitamin from the plant to the small animals, thence to the larger predatory fishes which follow the floating colonies. Such a process, combined with the drift of the Gulf Stream, may well contribute to the wide but unequal distribution of vitamin D in marine fish oils. Of interest in this connection is the report[9] that the cod livers taken from the White Sea and Bear Island region are consistently lower in vitamin D than those taken off Iceland in waters which are more accessible to the Gulf Stream.

The occurrence in plants of a vitamin D, in common with other vitamins, must now be recognized. The frequent association of vitamins A and D in fish liver oils is on these grounds easily understandable.

H. H. DARBY
H. T. CLARKE
COLUMBIA UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF BROMINE IN THE STERILIZATION OF FRUITS AND SEEDS

STERILE seedlings may be grown from seeds treated with any one of a number of substances. Calcium hypochlorite, as used by Wilson,[1] is perhaps the most popular of these, though mercuric chloride also has many advocates. An appreciable amount of time is needed for the mixing and filtering of bleaching powder, and the strength of the resulting solution is dependent on the age and condition of the powder. Mercuric chloride may cling to the seed coats and later injure the seedlings. A satisfactory sterilizing medium has been found in bromine, which I have used for more than two years with great success.

The best results have been gained with bromine water, which is diluted to 1/10 its original strength and poured over the seeds in a container, which is then tightly stoppered. Of course, care must be taken not to breathe the poisonous fumes of the bromine water. When the seed container is opened after sterilization, the weak solution does not fume sufficiently to be troublesome. Other dilutions may be used, but I have found it convenient to vary the length of time of sterilization rather than change the concentration of the sterilizing substance. The tolerance of seeds varies; oats are injured by exposures of more than one half hour, but corn, cabbage, radish and sunflower withstand an hour or more of treatment.

Bromine water has been used also in sterilizing fruits from which embryos were removed for growth in culture[2] and the chances of securing sterile embryos increased considerably thereby. In the tomato, immature ovules, even, may be removed from fruits and treated for one half hour without injury to the young embryos.

Fragments of stems and roots, treated in this manner, have been grown in sterile culture. Even leaves and flower buds have proved sterile in culture after bromine treatment, though it is not always possible to secure sterilization without fatal injury to these delicate structures.

No rinsing is required after bromine treatment, but the structures are placed at once on sterile filter paper, in liquid or on agar, as required. The bromine soon disappears, leaving no trace to injure later growth.

Bromine water will keep for long periods if stored in the dark. Shaking up the excess bromine in the water a few minutes before use insures a bromine content of satisfactory uniformity.

CARL D. LA RUE
UNIVERSITY OF MICHIGAN

[1] J. K. Wilson, *Amer. Jour. Bot.*, 2: 420–425, 1915.
[2] C. D. La Rue, *Proc. Nat. Acad. Sci.*, 22: 201–209, 1936; *Bull. Torr. Bot. Club*, 63: 365–382, 1936.

TO KEEP CULTURE-MEDIA FROM DRYING OUT

ONE of the problems of the small clinical laboratory and only a lesser problem in other laboratories is that of keeping culture-media ready for use, particularly Loeffler's medium, blood-agar slants and blood-agar plates. For this purpose and for preservation of stock cultures we have found a material called parafilm (made by the Marathon Paper Mills Co., Rothschild, Wisconsin) so useful that we wish to bring it to the attention of others. A square of this film pressed down on the mouth of a culture tube, the cotton plug

[9] Lovern, *Chem. Ind.*, 56: 75, 1937.

having first been pushed in, keeps the slant from drying out for weeks at incubator temperature and indefinitely at room temperature. It is equally efficient in keeping the volume of a broth tube or flask unchanged. The advantage over wax or paraffin is that the seal is readily stripped off and the cotton plug remains perfectly manageable. An inch-wide strip carried around the cover of a Petri dish and pressed down on the bottom of the dish allows prolonged incubation of a plate culture. Poured plates thus sealed are stacked for storage with waxed paper between to keep them from sticking together. The security of the seal may be seen in the following experiment: (1) 10 cc of alcohol in a graduated centrifuge tube lost nothing in volume in four days, during which time the same quantity in a cotton-stoppered tube, both in the 37° incubator, went down to 7 cc; (2) a tube of water at 54° kept the level unchanged for nine days, during which time the control went down an inch.

M. C. Terry

U. S. Veterans Hospital
Palo Alto, Calif.

DECLIVITY MAPS

Geographers are not alone in finding maps to indicate the degree of slope for a given land surface extremely useful. These maps are not common; and hence many researchers have gone to the field for this information. This procedure is unnecessary when large scale topographic maps with a small contour interval are available. Therefore, this brief paper deals with a method of gathering the essentials requisite for the construction of declivity maps from topographic maps.

The two essential data used in determining slope information are included in topographic maps. If one is to inspect below the diagrammatic, vertical section of a hill, prepared to illustrate certain features in the construction of a topographic map, it is obvious that the requisite information for the declivity map is available.

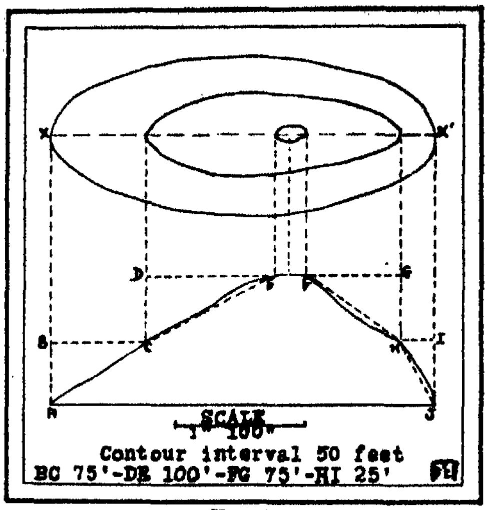

Fig. 1

If one wishes to determine the slope of the land between A and C, it may be calculated by solving for angle BCA, whose tangent is calculated by the distance AB as 50 feet (contour interval) and BC as 75 feet (by measure). In like manner the angles of DEC, GFH and IHJ may be ascertained. It follows then that these angles are the respective slope angles along the line XX′. To secure slopes elsewhere on the map, one has only to measure the distance between contours and substitute this formation with the contour interval, as indicated in the above method.

Place the computed angles mid-way between the contours where the slope has been determined. When the slope information has been recorded, generalize this information by the conventional isopleths, so familiar to geographers.

The number of observations will be governed by the degree of detail necessary for a given problem. Like all isoplethic maps, generally speaking, the greater the number of observations used for the map, the more faithful the map is to the truth.

It is suggested that a table be prepared with slope angles indicated as equivalents of the data discussed. The number of items necessary for a table will be governed, of course, by the degree of detail desired.

Floyd E. Masten

Pleasant Valley, N. Y.

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AGRICULTURAL RESEARCH IN CHINA*

By H. K. HAYES

CHIEF, DIVISION OF AGRONOMY AND PLANT GENETICS, UNIVERSITY OF MINNESOTA

DURING the summer of 1936 the writer visited many of the agricultural research institutions in Central and Northern China and observed the nature and extent of the investigations under way. From published papers in other countries which refer to work in China, such as the yearbook for 1936 of the United States Department of Agriculture which so adequately has summarized plant and animal breeding in the United States, it is apparent that there is little appreciation of the extent and nature of similar work in China. This is not strange, as until very recently there have been no adequate summaries in English. As the writer has been associated with leaders in agricultural research, affiliated with the Central Government of China or with various provincial departments and agricultural colleges, it seemed possible to make a survey that would give some idea of the nature and development of agricultural research in China in recent years. Data for this survey have been collected through correspondence with workers in various provinces and from members of the National Agricultural Research Bureau[1] in Nanking who are in touch with special phases of research throughout China. A summary by Director K. S. Sie,[2] of the National Agricultural Research Bureau, in the Chinese Year Book for 1935–36 has been of special value. The writer is greatly indebted to those who have so kindly made this information available.[3]

* Address of the vice-president and chairman of the Section on Agriculture, American Association for the Advancement of Science, Atlantic City, December, 1936.

1 The Nat. Agr. Res. Bur. Ministry of Industry. Miscellaneous Pub. No. 1. 1934.

2 K. S. Sie, "The Chinese Year Book," pp. 731–768. 1935–36.

3 The writer appreciates the helpful suggestions of the following members of the National Agricultural Research Bureau and of the National Rice and Wheat Improvement Institute: K. S. Sie, T. H. Chien, L. F. Chao, T. H. Shen (see Proceedings 5th Pacific Science Congress, pp. 573–579, 1933, Univ. of Toronto Press, and "A Coordinated Program of Wheat Breeding in China," in press, 1936), C. L. Pan, F. C. Woo, P. T. Sun, C. C. Kwan, S. C. Cheng, H. Tai, N. F. Chang, W. S. Tong and K. Ling. Paper

Before discussing various lines of research and experimental work under way it seems desirable to make a few observations regarding farming in China.

Some Farm Practices in China

While agricultural research in China is of rather recent development, the art of farming has been well worked out through centuries of trial and error.

In most regions the farmers live in villages and a farm consists of non-contiguous plots, in unfenced fields, the plots of a single farm often being located at some distance from each other. The size of farm is small, and Buck[4] states "that for China as a whole the size of farm is probably well under five acres."

Most of the farm work is done by hand labor, including planting, cultivating, harvesting, threshing and in some provinces carrying the crop to market. In East Central China, for example, the crop from the field usually is carried to the farm home by means of a carrying pole over the shoulders; and the threshed grain may be transported to market by the same means. In the north farm products are carried by donkeys, horses or mules. In the vicinity of large cities the streets are often lined in the early morning with farmers carrying their produce to market. The amount of human labor used in the farm operations can hardly be appreciated by any one who has not observed the conditions.

The utilization of all forms of organic waste products as fertilizers has led to a permanent system of conserving soil fertility. Farm manures and some other forms of organic waste products are generally composted before being returned to the soil. In East Central China, where rice is the main crop, pond and canal mud often is applied to the fields in large quantities, while ashes from fuel are an important fertilizer also. Near the large villages the use of "night soil" has led to excellent crop yields, although those fields that are at some distance from the village frequently appear deficient in productivity.

Satisfactory systems of crop sequence have been developed and are in common use. While more intensive methods are used in China than in the United States, the yields of wheat, on the average, according to Buck, are about the same in both countries, while corn and cotton yields are greater in the United States than in China. Rice yields are approximately 50 per cent. greater in China than in the United States. This comparison is somewhat misleading, as the growing of two or more crops per year in China is a common practice where seasonal conditions permit. Thus in Shantung Province in the flue-cured tobacco region a common practice is to grow winter wheat and tobacco the same year on the same land, the tobacco being transplanted after the wheat is harvested. This system of double cropping is an interesting one, the crops being used varying widely according to local and seasonal conditions.

A few of the better systems described by Buck give an idea of methods that are common in several localities (see Table 1).

TABLE 1

Province	Kind of land	Year	Winter and spring crops	Summer crops
Anhwei	Low	1st	Barley	Soybeans
	"	2nd	Wheat and field peas	Sesame or soybeans
	High	1st	Wheat	Soybeans
	"	2nd	"	Sesame
	"	3rd	Kaoliang	
Kiangsu	Paddy	1st	*Astragalus sinensis*	Rice
	"	"	Wheat	"
	Low	"	Barley	"
	"	2nd	Field peas or broad beans	"
	High	1st	Wheat	Soybeans
	"	2nd	Wheat or barley	Sweet potatoes
	"	3rd	Field peas or broad beans	Corn and soybeans

A particularly intensive system noted in one section of Anhwei Province consisted of winter wheat, followed by rice. A week or two before the rice was harvested soybeans were sown broadcast in the rice fields, making three crops per year. In most of these illustrations a legume appears rather frequently in the rotations.

Interplanting of crops is a common practice. These consist, in some cases, of a legume grown in association with a non-legume. Examples are wheat and field peas used as a winter crop in one of the rotations, while barley and broad beans are grown frequently in alternate narrow plots. Early and late rice are handled in the same way, some farmers believing that larger yields are obtained than by growing either early or late rice alone.

Fuel supply for both farm and city population consists to a considerable extent of crop plants. Thus the stalks of corn and kaoliang are used extensively for fuel. Coarse grass and weeds in waste areas are cut and dried for fuel. It is a common practice in some sections of the North to harvest wheat and kaoliang plants by pulling them, using the roots as well as the stalks for fuel. These practices, which are common in the North, have reduced the organic content and humus of the soil; and while it is appreciated that this is undesirable, there is no other available supply of fuel for cooking and heating.

Agricultural Colleges in China[5]

Agricultural research depends in general on at least two main factors. First, there must be an apprecia-

No. 348 of the Miscellaneous Journal Series, Minnesota Experiment Station.

[4] John Lossing Buck, "Chinese Farm Economy." The University of Nanking. 1930.

[5] S. C. Wang, "The Chinese Year Book," pp. 456–582, 1935–36.

tion of the value of such research and facilities must be furnished for conducting the research. Second, there must be a group of trained men available for carrying on the research. It may be well, therefore, to make a summary of the number of agricultural colleges in China and of the student population and to speak briefly regarding advanced training.

According to the report of the Minister of Education, there were 1,683 graduates in agriculture and forestry in 1933–34 from universities, colleges and technical schools of college grade. These are listed in Table 2.

TABLE 2

Name	Location	Auspices
National Central University	Nanking	Provincial
National University of Peiping ...	Peiping	"
University of Chekiang	Hangchow	"
Sun Yatsen University	Canton	"
National Wu-Han University	Wuchang	"
National University of Szechuan ..	Chengtu	"
University of Kwangsi	Wuchow	"
University of Honan	Kaifeng	"
University of Nanking	Nanking	Private
Lingnan University	Canton	"
Fukien Christian University	Foochow	"
Nantung College	Nantung	"
National Northwestern College of Agriculture and Forestry	Wukung	National
National Technical School of Veterinary Science	Shanghai	"
Hopei Provincial College of Agriculture	Paoting	Provincial
College of Education, Agr. Dept. ..	Wusih	"
Tech. School of Agr. of Kiangsi ...	Nanchang	"
Tech. School of Agr. of Shansi ...	Taiyuan	"
Inst. of Kansu Junior College of Agriculture	Langchow	"

Of this list of 19 institutions, 7 receive mainly provincial support, 8 receive support from the National Government, and 4 are privately supported.

At present there are only a few institutions that give opportunity for graduate work. These are: Sun Yatsen University, that offers graduate work in agricultural chemistry and in agricultural botany; Central University, with graduate work in plant breeding; and the University of Nanking, with graduate work in agricultural economics. The number of graduate students at these various institutions is very small. For this reason most persons engaged in agricultural research in China must obtain their graduate training in foreign countries. This is expensive and without doubt has greatly limited the number of men taking graduate training. During 1929–34, according to the report of the Minister of Education, 207 Chinese students went abroad for graduate study in agriculture and forestry. It seems very probable that, with the rapid increase in agricultural research in China in recent years, there will be also a great increase in graduate training and that this will lead to the development of graduate work in those colleges and universities in China that are best fitted to give such instruction.

The Development of Agricultural Research in China

One indication of the interest in agricultural research is the development in recent years of extensive work under the National Government. Important institutions under the Ministry of Industry include the National Agricultural Research Bureau in 1931 and the National Rice and Wheat Improvement Institute, organized in 1935. The Cotton Improvement Institute was organized in 1934 under the National Economic Council. These three institutions are located about five miles east of Nanking, where adequate buildings and land have been made available. The Division of Agricultural Economics of the National Agricultural Research Bureau made a survey of the experimental work in agriculture in 1933, including institutions under national, provincial and other auspices. While data were not secured for all provinces rather accurate data were obtained for several provinces. These data consisted of the nature of the work, the date of organization and the number of technical workers. The summary given here does not include the staff of those institutions engaged primarily in teaching. The sort of data obtained may be illustrated by the following examples. The cotton experiment station of Nantung College was organized in 1932 and has a technical staff of 13, and the Provincial Wheat Station at Huschow was organized in 1917 and has a technical staff of 9.

The data presented in Table 3 are summarized by periods for the provinces of Kiangsu, Chekiang and Shantung.

TABLE 3

Number of Research Stations Classified According to the Date the Work was Initiated and Total Number of Research Workers (data collected in 1933)

Province	Class for date of organization					No. of tech. workers
	Before 1915	1915–24	1925–30	Since 1930	Total	
Kiangsu ...	2	9	4	8	23	148
Chekiang ..		2	3	2	7	128
Shantung ..	1	4	1	3	9	60
Total	3	15	8	13	39	336

Of a total of 39 such research institutions in these three provinces, 13 or nearly one third have been organized during the last six-year period. These data, while not complete for all work organized since 1933, are sufficiently accurate to give a clear picture of the interest to-day in China in research and experimentation, which has as its aim the development of greater efficiency in agriculture.

The extent and nature of agricultural research in China will be discussed by summarizing briefly research in particular fields, including crop improvement, soils and fertilizers, plant pathology, entomology, horticulture, forestry, animal husbandry and veterinary science, and sericulture.

Crop Improvement: The breeding of improved varieties of crop plants and their distribution to farmers in China is without doubt the best developed of any line of agricultural work. This is due partly

to the organization in recent years of the National Rice and Wheat Improvement Institute, under the Ministry of Industry, and the Cotton Improvement Institute of the National Economic Council. For wheat, rice and cotton these national institutes are developing cooperation with various provincial institutions. Special training schools for technical workers have been held during the winter months, under the auspices of these institutions and the National Agricultural Research Bureau, which have given admirable opportunity for the development of coordination in research.

Recently the improvement of wheat in China has been placed on a coordinated basis through cooperation between the various agencies interested in wheat improvement. Cooperative regional trials, free exchange of materials and nation-wide nurseries consisting of the more important foreign and native varieties have been planned. The breeding for disease resistance is an important feature of this cooperative program. Similar programs are being organized for improvement work with rice, cotton, sweet and Irish potatoes.

The University of Nanking has had a great influence in the development of crop improvement in China. A project first initiated by Dean John H. Reisner, of the College of Agriculture of Nanking University, was enlarged in 1924 through cooperation between the University of Nanking, Cornell University and the International Education Board. Members of the staff in plant breeding of Cornell University directed the work and did much to create a nation-wide interest in China in crop improvement.

During the last summer the writer visited many plant breeding stations in Central and Northern China and was impressed with the large proportion of technical workers in plant breeding in these sections who are graduates of the University of Nanking. A recent report of the improvement project of the University of Nanking,[6] that has been extended to include cooperation with nine provinces and the National Government, describes three improved varieties of wheat, Nanking 2905, Kaifeng 124 and Nanhsuchow 61, an improved variety of barley called Kaifeng 313, Nanksoy 332 soybeans and an improved variety of native cotton called Million Dollar. Each of these varieties appears to be a great improvement in the section in which it is adapted over the native varieties now grown. These and other improved varieties are being increased rapidly.

Workers at Central University have been leaders in cotton and rice improvement; and, through cooperation between Central University and other institutions, several valuable varieties of cotton have been introduced from America and are being grown widely in China.

A partial picture of the extent of crop improvement work in China can be gained by listing the number of experiment stations working on crop breeding in China, as given by Sie, and the crops being worked with. *These consist of 56 stations that are breeding* cotton; 48, wheat; 38, rice; 15, millet; 17, kaoliang; 17, soybeans; 16, corn; and 37, miscellaneous crops. Extensive studies with tea, including tea improvement, are being carried on in Southern and Central China. From statistics gathered from experiment station workers in various provinces, it seems safe to conclude that there are from 5 to 20 project leaders in most of the provinces that are giving their entire time to studies of crop breeding. Each of these leaders has an average of 2 or 3 assistants, approximately half of those being graduates of agricultural colleges.

The field work at the institutions visited by the writer was well carried out and the extent of field trials fully as great as at similar institutions in the United States.

Soils and Fertilizers: The Colleges of Agriculture of Central University, Sun Yatsen University, the University of Nanking and the University of Chekiang have comprehensive courses in soils and fertilizers; while the Colleges of Agriculture at Nantung, the University of Peiping and the Provincial Universities of Hopei, Honan, Anhwei and Kwangsi also give course work in this field. Some of these institutions are well equipped and have rather extensive research under way on various soil and fertilizer problems, comprising field experiments with both organic and inorganic fertilizers, analyses of soils and manures, studies of alkali soils and other problems of local interest.

The Department of Soils and Fertilizers of the National Agricultural Research Bureau with a technical staff of six men have extensive field experiments in seven different provinces, in cooperation with 20 local experiment stations, and are studying fertilizer problems with wheat, rice and cotton. Besides comparing the value of N, P and K alone and in varying proportions, studies are being made of different kinds of organic and inorganic fertilizers, the effects of acidic-inorganic fertilizers when used alone, with lime, with organic manures or both and the residual effect of fertilizers on the succeeding crop.

Very few rotation experiments have been carried on in China, although in many cases the farmers have adopted what appear to be desirable sorts of crop sequences. In recent years the Soils Department of the National Agricultural Research Bureau has initiated several rotation studies in cooperation with local stations.

The Provincial Experiment Station of Chekiang

[6] H. H. Love, T. H. Shen, L. Y. Ma, R. V. Pih, Sheo Wang, S. P. Peng and Y. S. Chen, College of Agr. and For. Univ. of Nanking. Special Report No. 2. 1935.

has started recently comprehensive studies of soil and fertilizer problems with a technical staff of about 15 men. They are making comparative studies of available plant foods in the soils of their province by the following methods: (a) Mitscherlich's pot experimental method, (b) Neubauer's method, (c) the citric-acid method and (d) microbiological methods. They are using field experiments also for the direct study of the value of fertilizers.

The Cotton Improvement Institute of the National Economic Council is making rather extensive studies of manurial experiments in relation to cotton culture. A technical staff of two men is directing these experiments in various regions where cotton is of importance.

A soil survey was started in 1930 in East and Central China by C. F. Shaw, of California. This work was arranged by Dr. Buck, of the University of Nanking, to aid in a survey of land utilization. The work was continued by the Soils Division of the National Geological Survey of China under the direction of Robert L. Pendleton for a two-year period. Special bulletins called "Soil Bulletins" are published by the geological survey. In 1933 James Thorp from the United States was placed in charge of the soil survey. Ten assistants have aided in the studies and a comprehensive summary of the results of the survey is now in press. The work will be continued under the leadership of K. C. Hou.

The Provinces of Chekiang, Kwangsi, Kiangsu and Kwangtung have established their own survey program and a great deal of work has been done in Kwangtung Province.

This rather brief summary emphasizes the extent to which studies of soils and fertilizers have been initiated in recent years. The present indication is that this phase of agricultural research will be expanded further in the near future.

Plant Pathology: According to the report of K. S. Sie in the Yearbook for 1935–36 work in phytopathology was initiated in 1924 and since that time there has been rapid progress. The Phytopathological Society of China was organized in 1929 and now has 36 regular members. Approximately half of the agricultural colleges in China have well-organized departments or laboratories of phytopathology. Rather extensive surveys have been made of the diseases of the more important crop plants, including studies of fruit diseases and of some vegetable diseases. Methods of disease control worked out in foreign countries or in China have been made available to farmers.

Studies of disease resistance have been or are being made, including resistance of millet varieties to smut and downy mildew, resistance of wheat to flag, stinking and loose smuts and resistance of barley to covered smut. Reports of progress show the value of breeding for disease resistance. In recent years studies of resistance to leaf and stripe rusts of wheat have been started at the National Agricultural Research Bureau. Native varieties are susceptible to both diseases, for the most part, but many foreign varieties from both Europe and America are highly resistant.

Copper carbonate dust and other seed disinfectants have been used successfully to control some of the smuts of cereals.

(*To be concluded*)

OBITUARY

J. ERNEST G. YALDEN

THE sudden death of J. Ernest G. Yalden, of Leonia, N. J., of a heart attack on February 22, 1937, has taken from the number of scientific workers a remarkable individual. A man of wide interests and unusual ability, he developed as an avocation such skill in those matters which attracted him that he became perhaps better known for his work at home than for the distinguished service which he gave in the field of practical education.

Born in England in 1870, Yalden received his early training in the typical boys' school of the period, to be followed by a course in civil engineering at New York University, from which he graduated in 1893. After a few years in the practise of his profession, he was encouraged to submit to the trustees of the Baron de Hirsch Fund a plan for the trade school which they were contemplating. His ideas were so well thought out and so well organized that he was invited to put them into operation.

He thus became the first superintendent and moving spirit of the school, which, until its recent absorption by the New York City system, operated most successfully along the lines indicated in the original plan. The reports of the school written during this period have been carefully studied by those concerned with training for craftsmanship, and many of the ideas have been put to use elsewhere.

Yet the native curiosity of the man and its accompanying thoroughness led him through a host of other experiences which were to profit many besides himself. An enthusiastic yachtsman, he designed and built various boats, from canoes to sea-going yawls, one of which, named by him the *Hippocampus*, has figured in boating literature.

A lover of boats who was fond of mathematics could

hardly escape the lure of navigation and the study of astronomy. It is not surprising then to find Yalden, always a keen student of Euclid, an enthusiastic and leading member of the Association of Variable Star Observers. At his home he built, from his own design, as he did everything else, a compact observatory in which he installed a 4-inch Clark telescope, and with painstaking care adjusted instrument and mounting with a precision rare in small observatories.

His observations on variable stars were characteristically accurate, and before long he had extended his program to include lunar occultations. This led naturally to cooperation with Brown of Yale. Recognition of the excellence of this work was not confined to this country, as his election to the Royal Astronomical Society will testify. However, his observing time was limited, for there were demands for observatory designs. A long list of observatories for colleges, schools and private individuals could be compiled from among the products of his drawing board.

Perhaps Yalden was most widely known as an authority on dialing. He computed many dials, personally constructed models in order to check by experiment, and designed a large number which have been erected in various parts of the country. At the time of his death he had nearly completed the full plans for a large dial of outstanding interest as well as the computations for another. A brochure on dialing came from his pen a short time ago, and his notebooks are full of original and novel dial designs and problems.

Those who knew him best will realize that in these few words only a part of his life has been sketched. It is appropriate in this journal to record a tribute to a late fellow of the American Association for the Advancement of Science, and that those who knew him but slightly may better picture the real Yalden it is right to add at least a suggestion of his skill as a musician, his early friendship with Winslow Homer, his ability in photography, his love of the garden, his charm and patience with the young people who went to him with all kinds of problems, scientific to personal, and not least his loyalty and steadfastness to his many friends.

From a wide experience and his orderly habits of thought Yalden had reached definite conclusions, which might well be considered by all who cherish ambition for achievement in science. Because it was characteristic of the man, he might have written as his message to them: "We know best those things which we do ourselves. Learn by doing."

H. W. FARWELL

WILLIAM ALANSON WHITE

THE following resolutions were passed on March 9 by the council of the Academy of Medicine of Washington, D. C., on the occasion of the death of their president, William Alanson White.

William Alanson White had the true vocation of a physician. His life work covered the period of modern psychiatry. This was no chance relationship, but a real identification, because he was one of the principal creators and interpreters of present concepts in this domain of thought.

To this task he brought the well-balanced talents of a convincing teacher, lucid writer and eloquent speaker. His eminent ability and tremendous energy made him an enthusiastic leader in every enterprise which had for its purpose the increase of knowledge and the more effective use of all measures applied for the relief of the mentally ill, and for the betterment of human relationships. These activities were recognized by institutions of learning which conferred upon him honorary degrees, and by learned societies which bestowed upon him many offices of high honor.

Acquainted as he was through official duties and personal ministry with the weakest and worst of mankind, as well as the strong and good, brought by accident to confusion or disaster, his absorbing preoccupation was the observation and interpretation of human behavior as a manifestation of the personality in all its conflicts and strivings for adjustment and satisfying expression. As a physician he brought to human problems the knowledge of a scientist, the insight of an artist and the gentleness of a brother.

It is then not surprising that he became a philosopher, but it is an index to the nobility of his character that with his knowledge he was still an optimist. There was no man whom he was not willing to help, and no tangled skein of human relationships was so desperate that he could not find some golden thread to follow, by which he could intervene in a helpful manner.

He once compared the field of consciousness to the area of a night-time landscape, illuminated and revealed by a search light, showing clearly a middle ground with shadowy borders. In the world his light has gone out, but the field upon which its rays fell will not again be dark.

Whereas, by the death of Dr. William Alanson White, the Academy of Medicine of Washington, D. C., has lost its first president and the membership a dear and admired friend,

Therefore be it resolved, by the council, on behalf of the academy, that the foregoing sentiments be adopted in appreciation of his worth and as an expression of personal sorrow of the membership, and that the same be recorded in the archives of the academy.

RECENT DEATHS

DR. LEWIS MUHLENBERG HAUPT, consulting civil engineer, from 1875 to 1892 professor of civil engineering at the University of Pennsylvania, died on March 10 in his ninety-third year.

DR. WILLIS G. GREGORY, for forty-six years dean of the School of Pharmacy at the University of Buffalo,

N. Y., died on March 20 at the age of seventy-nine years.

WINFRED W. BRAMAN, until his retirement last October associate professor of animal nutrition at the Pennsylvania State College, died on March 24 in his sixty-third year.

EDWARD P. BURRELL, director of engineering for the Warner and Swasey Company, Cleveland, manufacturers of precision instruments and machinery, died on March 21 at the age of sixty-six years. He directed designing on the large telescopes built by the company during the last twenty years.

COLONEL C. G. THOMSON, superintendent of the Yosemite National Park, died on March 23. He was fifty-four years old.

SCIENTIFIC EVENTS

A PROPOSED SCHOOL OF TECHNOLOGY FOR NEW YORK CITY

MAYOR LA GUARDIA of New York City has announced that the capital outlay budget for the coming year will provide funds for the opening this autumn of the new city college in the Borough of Queens, to be housed in the buildings formerly occupied by the Queens Parental School near Flushing. The budget contains an item of $424,000 for the necessary reconstruction and equipment of the buildings. The mayor is reported to have said:

I would like to have one of our city colleges specialized as a school of technology, perhaps called the New York School of Technology. They tell me that the College of the City of New York is admirably equipped for this and could be utilized. Its mechanical equipment is adequate now, but it is short on laboratory equipment.

Another of the schools should specialize in government. It should be for government in all its branches and for all classes of employes. It would train in various branches of government such as finance, taxation, government accounting. There would be courses of clerical classes for those interested in going into this branch of government service and making a career of it.

Engineering as it applies to government, such as ferry operation and the like, would be taught. So would management and government purchasing methods. I wouldn't object to the training of young men who would enter the school with the idea of becoming policemen.

The plan has been submitted by the mayor to a few members of the Board of Higher Education, the non-salaried agency which controls the city's colleges. These members are to present it to the board for study and action. Mayor La Guardia continued:

This city has 7,000,000 population and is committed to the policy of free education; that is, I am. States with not anywhere near as large a population as this city have free state universities.

In New York City we have a transportation problem in connection with the colleges which we try to work out by routing the students against traffic, but, even so, attendance is difficult to many.

I think, too, that the city colleges have set an unreasonably high average mark as their entrance requirement, but this has been more or less necessary because the existing city colleges are overcrowded. The new college in Queens will take care of this. Whether or not the new Queens college is to be a general college will be up to the Board of Higher Education.

The mayor pointed out that City College, Hunter College and Brooklyn College are all overcrowded, a condition which will be eased when the new Queens College is opened. Any changes that may be made will not interfere with students now on the college rolls. None of them would be required to change the institution at which they are now studying.

HONORARY FELLOWSHIPS FOR STUDENT EXECUTIVES AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PRESIDENT KARL T. COMPTON, of the Massachusetts Institute of Technology, has announced the details of a plan for the preparation of young executives for business and industrial positions. This is the continuation of a five-year experimental program which has proved of value not only to the students but to industry as well.

It is proposed to establish a system of honorary fellowships sponsored by thirty-five distinguished business and industrial executives. Beginning in June, fifteen students on leave of absence from their employers will begin a twelve months' intensive program of study consisting of a summer session and a year of graduate education. The selection is now being made from a large group of technically trained men in business and industry. The fellowships will be awarded by invitation only to men of exceptional executive promise, intellectual capacity and physical resource. They will come from the more mature group of younger executives who have had several years of industrial experience following collegiate training in science or engineering.

The establishment of the program is made possible by an anonymous gift of $25,000, providing for scholarship stipends of $1,450 for single men and $1,950 for married students. The course will lead to the degree of master of science in business and engineering administration.

In making the announcement, Dr. Compton said: "The experience of the small group of honorary fellows during our experimental program of the past five years and their remarkable record of success following their fellowship year is convincing evidence of the soundness of this step in administrative education."

The new program will be under the direction of Professor Erwin H. Schell, head of the department of business and engineering administration, who has been in charge of the five-year experimental plan, aided by an advisory committee of educators and executives.

Members of the committee have been appointed as follows: Dr. A. Lawrence Lowell, formerly president of Harvard University; President Frank Aydelotte, of Swarthmore College; The Reverend Leslie Glenn, rector of Christ Church, Cambridge; Edmund C. Mayo, president of the Gorham Manufacturing Company, and President Karl T. Compton, of the Massachusetts Institute of Technology. The faculty will include authorities in the various fields to be covered, business executives collaborating in special studies.

The honorary fellows will live together as a special group, and part of their training will include administrative seminars, weekly conferences with distinguished business and industrial administrators and original research. The unmarried fellows will have quarters in the Graduate House, with a special dining-room and a conference lounge set aside for weekly dinners and business conferences with industrial executives. Special provisions will be made for housing married students.

GEOLOGICAL MAP OF LABERGE AREA, YUKON

A FOUR-MILE-TO-THE-INCH colored geological map of the Laberge Area, Yukon, showing geological boundaries, topography, roads, trails and other features, has been issued by the Geological Survey, Department of Mines and Resources, Ottawa. The map is based on investigations made in recent years by W. E. Cockfield, H. S. Bostock and E. J. Lees and forms a connecting link between the work done in the southern and in the west-central regions of Yukon. It shows the main route of travel down the Lewes River, and should accordingly be particularly useful to prospectors unfamiliar with the region.

Although the Laberge area is traversed by the main water and land routes in Yukon Territory, it has received little attention from the hundreds of prospectors that have traveled the routes on their way to the Klondike area. It is apparent from the investigation made by the department, however, that several sections of the 4,600 square mile area merit attention. In general it has been found that the western half of the area gives promise of yielding non-metallic minerals, particularly coal, in commercial quantities and that the formations in the eastern half are suitable for the occurrence of metals. All known coal deposits are shown on the map, and all are within easy reach of transportation. There has been no production from these deposits, but some of them are similar in nature to those that have been under development for years in the Carmacks area to the northwest.

Placer gold deposits were first discovered in the area in 1881, and deposits have since been found on the bars of Lewes, Teslin and Big Salmon rivers, and on several creeks along the western slope of the Big Salmon range. Lode copper-gold deposits have been found at Loon Lake, and some veins have been staked for lode gold on Livingston Creek, at present the most important source of placer gold output in the area.

THE COAL RESEARCH LABORATORY OF THE CARNEGIE INSTITUTE OF TECHNOLOGY

ACCORDING to the report of a committee appointed by the Board of Trustees of the Carnegie Institute of Technology, of which Dr. Thomas S. Baker is chairman, the sum of approximately $350,000 has been subscribed for the support of the Coal Research Laboratory, thus assuring its continuance for four more years.

Formal announcement was made on March 24, at a meeting in the Engineering Societies Building in New York, attended by representatives of the companies and organizations which are the financial sponsors of the laboratory. A report on the scientific investigations being made at the laboratory was given at the meeting by Dr. H. H. Lowry, director.

The fund committee, which, besides Dr. Baker, consists of Dr. John Johnston, director of research for the United States Steel Corporation, and Howard N. Eavenson, mining engineer of Pittsburgh, began work a year ago to secure additional funds for the continuance of the laboratory. In 1930, when it was founded, sufficient funds for a six-year research program on bituminous coal were given by the Buhl Foundation, the Carnegie Institute of Technology and by six large industrial firms, namely, the U. S. Steel Corporation, the General Electric Company, the Koppers Company, the New York Edison Company, the Standard Oil Company of New Jersey and the Westinghouse Electric and Manufacturing Company.

Through the efforts of the committee, a large number of companies have become sufficiently interested in the work of the laboratory to promise financial aid. Whereas the original grant was secured from a small number of companies, the Buhl Foundation and the Carnegie Institute of Technology, the gifts secured by this committee have been made by a more diversified group of interests, particularly by coal-mine owners and railroads.

The original sponsors for the laboratory which have again given financial support include the Buhl Foundation, the Carnegie Institute of Technology, the U. S. Steel Corporation and the General Electric Company. Contributions now have been made by twenty organizations that did not originally support the laboratory. The members of the fund-raising committee are also members of the technical committee which arranges the scientific program of the laboratory.

SEISMOLOGICAL OBSERVATORY AT WILLIAMS COLLEGE

A SEISMOGRAPH has recently been placed in operation at Williams College. The installation is a gift of Mr. and Mrs. John S. Palmer, 2nd, of Providence, R. I., in memory of their son, Julius Palmer, who, with two of his classmates and Professor Herdman F. Cleland, was lost in the sinking of the steamship *Mohawk* on January 24, 1935.

The station has been placed in the sub-basement of the geological museum at Lat. 42° 42.85′ N., Long. 73° 12.66′ W., elevation 219 meters, and rests on solid Cambrian dolomite a few inches below the floor level. The instruments consist of a Benioff vertical-component seismometer connected with long and short period Miller galvanometers. Time control is obtained from a Seth Thomas regulator clock, registering minute and hour marks on the records and checked daily by U. S. Naval Observatory time signals. The separate rooms for seismometer, recording units, photographic work and radio time control are all constructed of hollow tile and effectively insulate the equipment from the remainder of the building. Very little interference by vibrations from street traffic, trains or disturbances originating in the building is evident on the records.

Dr. N. H. Heck, president of the Seismological Society of America and chief of the Section of Terrestrial Magnetism and Seismology of the U. S. Coast and Geodetic Survey, delivered a brief address at the dedication of the observatory on February 22, outlining the several contributions which may be expected from an installation of this type. Arrangements have been made to cooperate with Science Service and the U. S. Coast and Geodetic Survey in the study of teleseismic activity, while a study of local earthquakes will be made in cooperation with the other Benioff-equipped stations of New England located at Harvard, Weston and Burlington.

ELWYN L. PERRY

SCIENTIFIC NOTES AND NEWS

THE French decoration of Commander of the Legion of Honor was on March 16 conferred on Dr. Robert A. Millikan, of the California Institute of Technology, for his work "in the fields of science and international relations." M. Pascal Bonetti, delegate of the French Ministry of Public Instruction, traveled to the United States especially to bring the award. M. Jean Viala, French consul at Los Angeles, made the presentation.

DR. NIELS BOHR, Hitchcock lecturer at the University of California, was awarded the degree of LL.D. at the Charter Day exercises of the university on March 23. In conferring the degree, President Robert G. Sproul said: "Clear and penetrating thinker concerning the most abstruse problems of the physical world; herald of the concept which is the basis of modern study of the structure of matter; specialist endowed with the highest form of scientific imagination; blessed and blessing with kindliness and true humanity."

IT is announced by the senate of the University of Edinburgh that an honorary degree will be conferred by the university on Dr. L. H. Baekeland, honorary professor of chemical engineering at Columbia University.

A COMMITTEE representing the departments of philosophy of Amherst College, the University of Minnesota and Columbia University honored Dr. Frederick J. E. Woodbridge, Johnsonian professor of philosophy at Columbia University, on the anniversary of his seventieth birthday. The ceremony was held in the Harkness Pavilion of the Columbia-Presbyterian Medical Center, where he is convalescing after an operation. The committee presented to Dr. Woodbridge a volume of his own essays and addresses collected by his former students and associates and published in recognition of the anniversary.

THE New York University College of Engineering will dedicate a new building and power plant in honor of Dr. Collins P. Bliss, dean emeritus, on April 3 at 11:30 A. M. Dr. Bliss retired as administrative head of the college last July after serving for forty years as a member of the faculty. He was succeeded by Dean Thorndike Saville. Dr. W. R. Gregg, chief of the U. S. Weather Bureau; Arthur S. Tuttle, New York state director of the Federal Emergency Administration of Public Works and project engineer of the PWA Queens Midtown Tunnel, who is chairman of the Committee on Engineering of the New York University Council; Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, and Dr. Harvey N. Davis, president of the Stevens Institute of Technology, are among the speakers who will participate in the ceremonies.

PRESENTATION of the Mendel Medal of Villanova College was made by the Very Rev. Edward V. Stanford, president of the college, at a faculty dinner on March 22, to Père Pierre Teilhard de Chardin, S.J., discoverer of the Peking man. M. de Chardin came to the United States to attend the International Symposium on Early Man at the Academy of Natural Sciences of Philadelphia.

DR. ROBERT BROOM, paleontologist of the Transvaal Museum, Pretoria, South Africa, will be the guest of honor at a dinner to be given on April 7 by the Friends of Barnard College. He will speak on "South Africa's Contribution to the Origin of Man." Dean Virginia C. Gildersleeve will preside, and Professor Henry E. Crampton, head of the department of zoology, will be among the speakers.

DR. HAROLD SAFT OLCOTT, research associate at the State University of Iowa, has been chosen by a committee of the American Chemical Society to receive the second Eli Lilly and Company award in biological chemistry, carrying $1,000 and a bronze medal. Dr. Olcott will receive the prize at the opening session of the ninety-third meeting of the society at the University of North Carolina on April 12.

OFFICERS of the Academy of Science of St. Louis elected for the year 1937 are: The Rev. Jas. B. Macelwane, S.J., *president;* Dr. W. H. Roever, *first vice-president;* Professor W. F. Shay, *second vice-president;* Professor W. D. Shipton, *secretary;* Professor C. H. Philpott, *treasurer;* Dr. E. P. Meiners, *librarian;* Professor Paul E. Kretzmann, Dr. Alphonse McMahon, J. H. Porter and Dr. Harold A. Bulger, *councillors-at-large.*

DR. ALBERT JOHANNSEN, professor of geology at the University of Chicago, has retired after more than twenty-seven years in the service of the university. The department of geology is planning to issue in his honor a special volume of *The Journal of Geology,* made up of papers and photographs contributed, for the most part, by his former students.

DR. J. H. JAMES, head of the department of chemical engineering and a member of the original faculty of the Carnegie Institute of Technology, has been granted a year's leave of absence, following which he will retire from teaching.

DR. HERBERT EUGENE WALTER, professor of biology at Brown University and a member of the faculty since 1906, will retire in June to become professor emeritus after forty-one years of active service in the fields of genetics and comparative anatomy. He will be seventy years old on April 19.

PROFESSOR RALPH T. KING, of the department of economic zoology of the University of Minnesota, has been appointed head of the department of zoology and of the Roosevelt Wild Life Forest Experiment Station of the New York State College of Forestry, Syracuse University. He will fill the vacancy caused by the death of Dr. Charles E. Johnson..

DR. ROBERT M. MOORE, assistant professor of pathology of the School of Medicine of the University of Missouri, has been appointed professor of pathology and director of clinical laboratory diagnosis in the School of Medicine of the University of Mississippi.

KNOWLES A. RYERSON, until recently chief of the Bureau of Plant Industry of the U. S. Department of Agriculture, has been appointed to succeed Dr. W. L. Howard as director of the branch of the College of Agriculture of the University of California at Davis. Dr. Howard, who has served as director since 1924, will continue as professor of pomology.

DR. WALTER T. HARRISON, senior surgeon in the National Institute of Health, has been placed in charge of the Division of Biological Control of the U. S. Public Health Service.

EDMUND SECREST, state forester, has been appointed director of the Ohio Agricultural Experiment Station at Wooster. He succeeds Dr. C. G. Williams, who will retire on July 1, after having been on the staff continuously for thirty-four years.

THE Committee on Scientific Research of the American Medical Association has made a grant to Dr. Samuel Soskin, director of metabolic and endocrine research at the Michael Reese Hospital, Chicago, to aid his work on the hormone assay of blood and urine in endocrine dysfunction.

DR. H. K. HAYES, chief of the Division of Agronomy and Plant Genetics, University of Minnesota, has returned after spending the past year directing research activities and graduate study at the University of Nanking.

PROFESSOR GEORGE MIKSCH SUTTON, artist, curator of birds at Cornell University, will spend the coming spring in the southwestern United States, centering his attention upon a state-wide survey of the bird-life of Oklahoma. He will leave Ithaca about April 10.

DR. J. NEYMAN, reader in statistics at University College, London, arrived in New York on April 1 for a stay of six weeks. He will deliver lectures and hold conferences at Princeton, the Graduate School of the U. S. Department of Agriculture, Columbia, Brown, Chicago, Michigan, Illinois, Iowa and Iowa State College. Dr. Neyman founded the Statistical Laboratory of the Central Agricultural Institute at Warsaw, and has done pioneer work in the interpretation of experiments in bacteriology, crop yield and social censuses.

Dr. Leo Loeb, professor emeritus of pathology of the Washington University School of Medicine, St. Louis, gave on March 30 the fourth Arno B. Luckhardt lecture, under the auspices of the Delta chapter of Phi Beta Pi. His subject was "The Biological Basis of Individuality."

Dr. W. F. G. Swann, director of the Bartol Foundation of the Franklin Institute, will deliver at New York University on April 9 at 8:30 P. M. a James Arthur lecture, entitled "What is Time?" Dr. R. W. Gerard, of the University of Chicago, will give on April 15 a James Arthur lecture at the American Museum of Natural History at 8:15 P. M. He will speak on "Dynamic Neural Patterns."

Dr. Earle Raymond Hedrick, professor of mathematics, vice-president and provost of the University of California at Los Angeles, gave the Charter-day address on the occasion of the sixty-ninth anniversary of the founding of the University of California on March 19.

Dr. Arthur H. Compton, professor of physics at the University of Chicago, delivered on Easter Sunday under the auspices of the National Broadcasting Company a radio address entitled "We Must Shape Our New World."

Dr. Theophilus S. Painter, professor of zoology at the University of Texas, delivered an address on "Recent Developments in our Knowledge of Chromosome Structure" before the Brown University Chapter of Sigma Xi on March 19.

The Rev. V. C. Stechschulte, S.J., director of the Xavier Seismological Observatory, on March 18 addressed the University of Cincinnati chapter of Sigma Xi on "Earthquakes and Seismographs."

The Federation of American Societies of Experimental Biology, which includes the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics and the American Society for Experimental Pathology, will hold its annual meeting under the presidency of Dr. Arno B. Luckhardt, of the University of Chicago, at Memphis, Tenn., from April 20 to 24.

The two hundred and thirteenth regular meeting of the American Physical Society will be held in Washington, D. C., on Thursday, Friday and Saturday, April 29, 30 and May 1. The Thursday and Friday sessions will be held at the National Bureau of Standards and the Saturday sessions at the George Washington University. Other meetings for the current season are as follows: June 21 to 25, Denver, Colo., the Pacific Coast Section in affiliation with the American Association for the Advancement of Science; June 22 and 23, Madison, Wis.; November 26 and 27, Chicago, Ill.; Pacific Coast meeting, December, 1937; annual meeting, in affiliation with the American Association for the Advancement of Science, December 27, 1937, to January 1, 1938, Indianapolis, Ind.

The eighth spring meeting of the Eastern Branch of the American Psychological Association will be held on Saturday, April 3, at Vassar College, Poughkeepsie, N. Y. Morning sessions will be devoted to conditioned responses, sensory processes, abnormal psychology and attitudes. At a luncheon the honorary president, Dr. Samuel W. Fernberger, of the University of Pennsylvania, will deliver an address on "A Psychological Cycle." The afternoon sessions will be divided into five groups—learning and memory, brain processes, comparative psychology, psychometrics and applied psychology. A tea will conclude the meeting.

The annual meetings of the Pacific Coast Branches of the Paleontological Society, the Seismological Society of America and the Cordilleran Section of the Geological Society of America will be held at the University of California on April 9 and 10.

A mathematical symposium on "The Calculus of Variations" will be held at the University of Notre Dame on Wednesday and Thursday, April 7 and 8. Leading authorities in the field have accepted invitations to present papers and to engage in the discussion. The last session will be devoted to applications of the calculus of variations in the fields of economics and physics. The program includes a general lecture on "What is Topology?" by Dr. Solomon Lefschetz, of Princeton University, president of the American Mathematical Society.

The California Institute of Technology has received an anonymous gift of $750,000 to be used in the Division of the Humanities.

The will of Dr. Edward S. Robinson, professor of psychology at Yale University, leaves his estate in trust to his mother, Mrs. Carrie S. Robinson, of Wheeling, W. Va., for life, and after her death the trust passes to Yale University.

Dr. William Johnson Sollas, professor of geology and paleontology at the University of Oxford, who died last October at the age of eighty-seven years, left his estate of the gross value of £15,937, subject to life interests, "to found a fellowship at University College, Oxford, for the advancement of knowledge in some branch of geology."

There has been established at Colgate University the McGregory fellowship in chemistry, to be awarded to a member of the graduating class each year for graduate study in chemistry in the United States or abroad, the McGregory Lectureship, a fund to be used

to bring guest lecturers on chemical subjects to the university each year, and a fund for the purchase of books on chemistry for the departmental library. These funds represent the annual income from the estate of the late Joseph Frank McGregory, professor and head of the department of chemistry for forty-five years, and are being used in accordance with the terms of his will.

A DAVID ANDERSON-BERRY GOLD MEDAL, together with a sum of money amounting to about £100, will be awarded in July, 1938, by the Royal Society of Edinburgh to the person, who, in the opinion of the council, has recently produced the best work on the nature of x-rays in their therapeutical effect on human diseases. A similar award will be made every three years. Applications may be based on both published and unpublished work and should be accompanied by copies of relevant papers. They must be in the hands of the General Secretary of the Royal Society of Edinburgh by June 1, 1938.

THE United States Senate passed on March 23 the amendment to the 1934 Communications Act, making it possible for the Cruft Laboratory at Harvard University to resume experiments in automatic radio devices that offer high promise for use in police protective work and in other fields. The 1934 law made it necessary for the Cruft station to shut down for lack of a licensed operator. The Cruft Laboratory had been employing an automatic device capable of preventing improper operation of the station, and informed the Federal Communications Commission that it could not afford to keep an operator on duty throughout continuous operation. The amendment authorizes the commission to make special regulations governing the use of automatic radio devices.

IT is reported in *Nature* that at the annual general meeting on March 10 of the British Institute of Metals the president of the institute announced that, as a first step in a plan of cooperation with the Iron and Steel Institute, members of each institute can become members, associates and student members of the British inapplication. Combined annual subscriptions and entrance fees have also been arranged. The present scheme of cooperation follows one recently completed by the two institutes with the American Institute of Mining and Metallurgical Engineers, whereby members, associates and student members of the British Institutes may, if under the age of thirty-three years, become junior foreign affiliates of the American Institute of Mining and Metallurgical Engineers on specially favorable terms, the arrangement being reciprocal in the case of members of the American society. The president also announced that the council had decided to issue an appeal for the creation of an endowment fund, to be invested for the support and extension of the work of the institute.

DISCUSSION

HURRICANE PALMS IN FLORIDA, INCLUDING A NEW GENUS SIMPSONIA

THE native flora of southern Florida is truly tropical, with ten indigenous genera of palms, nearly as many as the entire continent of Africa. Five of the native genera, Roystonea, Inodes, Paurotis, Serenoa and Simpsonia, are specially adapted to exposed situations, together with the coconut and other resistant types that have been introduced. Some of the native Florida palms are scarcely known in collections, but have special value for open plantings where wind resistance is desired, with beauty and variety. Even against the trade-winds, gardens or orchards often need protection, and districts with many resistant palms undoubtedly would suffer less from hurricanes or from the fires and frosts that visit denuded districts in the dry winter season. Making Florida a winter paradise may appear more important than planting for production, though for either purpose groves or shelter-belts of palms would be of value.

Palms are specialized for particular environments more than has been appreciated, in three rather definite ecological series: First, the sun palms, requiring full exposure; second, the palms that live as forest trees; and third, the undergrowth palms, adapted to permanent shade conditions. The primitive palms doubtless were plants of open country, like those now confined to seacoasts, sand dunes or rocky deserts. The tree palms develop in partial shade through their seedling and juvenile stages, but eventually over-top the forest and reach the sunlight. Palms from forests usually thrive in conservatories, while sun palms languish or die. Adaptive characters often are omitted from taxonomic descriptions but need to be known before new plants can be grown and appreciated.

The resistance of the coconut palm is featured in many accounts of hurricanes in low-lying coral islands in the Pacific Ocean. All the other trees may uproot and wash away, but coconut palms hold fast and the natives take refuge aloft. Many coconut palms withstood the hurricane that visited Palm Beach, Fla., on September 16, 1928, while most of the branching "hardwood" trees were completely wrecked. The native royal palms, *Roystonea floridana,* also showed a

notable resistance, their massive trunks often remaining in place where neighboring coconut palms were broken off or uprooted. The specialized features of royal palms are the smooth rigid trunks, the compact bundle of leaf sheaths protecting the terminal bud, and the stiff, brittle petioles where the leaves break off and thus "shorten sail" in severe winds. New crowns of leaves are put forth in a few months, before the coconut palms can replace their rusty, storm-frayed foliage.

Another resistant type was signalized at Palm Beach, the Mascarene cabbage palm, *Linoma alba*, earlier known as Areca or Dictyosperma, that stood entirely unhurt among the wreckage of the gardens, and began to be known as "the hurricane palm." It is smaller than the coconut palm, with leaves of similar form, but so firm and fibrous as not to be whipped or shredded by the wind. Linoma is a native of Mauritius, one of the Mascarene islands in the hurricane belt of the Indian Ocean, famous a century ago as the setting of "Paul and Virginia," an idyl of tropical felicity published at the beginning of the French Revolution by Bernardin de Saint Pierre, the friend and successor of Rousseau in preaching the return to nature.

Linoma doubtless will be planted in larger numbers, since seeding palms are becoming frequent. As the *chou palmiste* of Mauritius it has repute as a delicious salad, and tinned "palm hearts" have been an article of export from the neighboring island of Reunion. The different kinds of palm hearts might be compared and their dietary uses developed if large groves or shelter-belts were established. Planting the Florida palmetto for its cabbage has been suggested, but royal palms grow much faster and their edible buds are larger.

The native cabbage palmetto (*Inodes palmetto*) and the even more abundant saw palmetto (*Serenoa serrulata*) belong to the series of hurricane palms, and are resistant also to drought, fire and frost, so that vast areas are occupied, that give Florida preeminence as a palm country. The low reclining trunks of the saw palmetto rise in groups from branching underground root-stocks and furnish an ideal cover for embankments, sand dunes or sea coasts, though very difficult to remove in clearing land.

Paurotis is a larger social palm, with slender trunks 20 to 30 feet high forming dense hurricane barriers or growing in graceful clusters, not exceeded in beauty by any other palm. The foliage is not bluish or grayish as in Serenoa, but a shining emerald green, with the long, light-yellow inflorescences rising like jets from a fountain. Paurotis is very intolerant of shade, and in the wild state is restricted to small hammocks in open fire-swept stretches of the Everglades, rarely visited by tourists. The awkward name Acoelorraphe often is applied to Paurotis, but its original use by Wendland in 1879 referred to the saw palmetto.

The new genus of hurricane palms is an example of specialization for an extreme habitat on naked limestone formations of the lower Florida Keys. It is not a social palm, but compact and robust, attaining 25 to 30 feet, notably larger than Thrinax or Coccothrinax, and thriving entirely in the open, beyond the range of other woody vegetation. The outstanding adaptive feature is the development of large cushions of fine interlacing superficial roots at the base of the trunk, like the spongy aerial root-growth of some of the orchids and other epiphytic plants. The leaves are close-veined and firm-textured like those of Linoma, with a chalky white coating of the lower surface, doubtless reducing transpiration. Small white berries are produced in great abundance, and very small seeds, finding lodgment in narrow crevices.

For this most specialized native palm the name *Simpsonia* is proposed as a tribute of regard and admiration for the late Charles Torrey Simpson, whom future times may recognize as a great pioneer naturalist of tropical Florida. The genus is next to Thrinax, but with several diagnostic characters, the massive columnar trunk, often more than a foot in diameter, acervate radicels, cretaceous induments, subsessile flowers, imperforate endosperm and lateral embryo. The type species, *Simpsonia microcarpa* (Sargent) is described and illustrated in Sargent's "Silva of North America" (2: 53) as *Thrinax microcarpa*, from No Name Key, and later in the same work (14: 83) as *Thrinax keyensis*, a larger form from the Marquesas Keys, west of Key West. A thrifty specimen of the type species was raised by Simpson in his garden near Little River.

O. F. COOK

BUREAU OF PLANT INDUSTRY
U. S. DEPARTMENT OF AGRICULTURE

CARBONATION AND CARBONATIZATION

W. A. TARR recently argued against the use in geology of the term "carbonatization," and supported his view-point with a list of several text-books that employ the simpler term "carbonation."[1] The present writer takes no issue with the general argument, as suggested by his adoption of the shorter term in a book that antedates at least two of those in Tarr's list.[2] Every question merits examination on both sides, however, and it is of interest to inquire why some geologists have preferred the longer and less attractive word.

"Carbonation" is the logical derivative of the verb "carbonate," which may appear to relate directly to the formation of carbonates. Unfortunately, several

[1] SCIENCE, 85: 198, 1937.

[2] C. R. Longwell, A. Knopf and R. F. Flint, "Textbook of Geology," Part I, p. 17, 1932.

dictionaries give as their first definition of this verb, "to carbonize; to reduce to carbon." One dictionary (The Universal) gives no other definition, and another (The Century, 1911 ed.) omits any mention of this meaning, giving as the sole definition, "to impregnate or saturate with carbonic acid" (as in the formation of carbonated waters). The New Standard Dictionary gives both meanings listed above, but does not mention the formation of carbonates. Webster's New International, which probably is used as widely as any dictionary in this country, defines "carbonate" (the verb) as follows (1934 ed.): "1. To burn to carbon; carbonize. 2. *Chem.* a, To convert into a carbonate. b, To impregnate with carbonic acid or carbon dioxide." This same dictionary, and others, define "carbonation" as "act or process of carbonating," thus involving the noun in the diverse usage of the verb. Dictionary makers, then, do not by any means give the unequivocal guidance suggested in Tarr's note. Since "carbonize" is given as a synonym of "carbonate," there appears to be dictionary license for using "carbonation" in reference to the accumulation of organic matter in soils or in marine muds; the concentration of fixed carbon in maturing coals; the charging of subsurface waters with carbon dioxide; and the development of carbonates, either by weathering or by hydrothermal action. Although this full range of license is not met in common usage, geologists show no disposition to restrict "carbonation" to one specific meaning.

Probably "carbonatization" originated from a desire to have a term that means unmistakably the development of carbonates. Certainly this desire explains the use of the word by some writers within recent years. Another and apparently older form, "carbonatation,"[3] may have had its origin in the same consideration. Users of these longer words in lieu of "carbonation" probably have felt that clearness is more important than euphony in scientific writing. They need not be disturbed by lack of conformity with the words "hydration" and "oxidation." The English language is not noted for exact consistency in word-form; moreover, any one disposed to quibble in this matter might claim that if "carbonation" and "hydration" refer to production of carbonates and hydrates, then "oxidation" should signify the formation of *oxidates!* It is a more effective argument that "hydration" and "oxidation," as now defined and used, are not in any way ambiguous, whereas "carbonation" may be misunderstood.

Thus the advocates of "carbonatization" are not without justification. They could even compile an imposing list of articles and books to make a case on the ground of usage. However, the writer has used "carbonation" in reference to the formation of carbonates, for the following reasons: (1) The verb "carbonize" and its derivative "carbonization" are adequate in expressing reduction to and impregnation with carbon; if geologists are careful to observe this logical usage, considerable confusion will be avoided. (2) Although the verb "carbonate" and its noun "carbonation" must still do double duty, ordinarily it should be clear from the context whether the formation of carbonates or merely charging with carbon dioxide is intended. However, the more cumbersome "carbonatization" at least has the advantage of precision, and the present writer will not be unhappy if he continues to meet the term in geologic literature.

[3] *Cf.* Century Dictionary, 1889 and later editions.

C. R. LONGWELL

YALE UNIVERSITY

THOSE annotating changes in scientific vocabulary are probably aware of the roots of the English language. Yet workers rarely employ the devices of philology. We, naturally, say "rarefaction," but would not suggest "rarization." Yet the form mentioned recently in SCIENCE, "carbonization," means to render foreign, as of shoes, using rough, uncivilized leather. The chemists can not have thought twice. (Greek, *Karbanos*, page 137, Hamilton, London, Crosby, Lockwood and Co., 1887; *-ize* is Greek.)

The Latin word *carbo(n)* means "coals." Its etymology is thought dubious (White, Ginn and Co., Boston, 1893, page 95). The form *ifaction* is good Latin: "Carbonifaction" or "carbonify."

We do say "temporize." And do not say "temporization." It is possible to say "temporizing." Instead of the term "carbonatization" for "carbonating," why not use it? And for products or processes "carbonators" and "carbonative," "carbonifactors" and "carbonificients," as well as "carbonifacts"? And "carbonatifacts," with "carbonatifactors" and "carbonatories"?

THOMAS HORACE EVANS

THE FIRST RECORD OF THE BLACK WIDOW SPIDER FOR IOWA

IN "Notes on the Distribution of the Black Widow Spider," by L. D. Anderson and H. G. Walker, in SCIENCE for January 22, 1937, Minnesota and Iowa are listed as the only states from which this spider has not been officially recorded. The writer believes that Iowa may be added to the "black list."

In the fall of 1936 a specimen was collected in the warehouse of a Cedar Rapids machinery company. While the author identified the specimen as a female black widow spider, the unusual color markings, combined with the fact that this species of spider had not been reported from Iowa, made him cautious about reporting it without verification. It was first sent to Donald G. Lowrie, of the University of Chicago, who

verified the author's identification. He suggested that because of its unusual color markings it might be a geographical subspecies. The markings were not typical for any of the three varieties described for the United States by Chamberlain and Ivie,[1] so it was then sent to Professor Chamberlain, who identified it as an extreme variation of *Latrodectus mactans texanus*. Since this spider was collected in a warehouse, it was thought that it might represent an import; but Professor Chamberlain stated that while this is a possibility it need not be true; that while Iowa would be the northern range for it, the form no doubt occurs here, as it is not uncommon in Kansas.

Field studies will be made next summer in an effort to determine the abundance and varieties of the black widow spider in this locality, and it will be especially interesting to observe whether the extreme variation of this first record will be found again in future investigations.

KARL A. STILES

COE COLLEGE
CEDAR RAPIDS, IOWA

[1] *Bull. of the University of Utah*, Vol. 26, No. 8, 1935.

SOCIETIES AND MEETINGS

THE PENNSYLVANIA ACADEMY OF SCIENCE

THE regular annual meeting of the Pennsylvania Academy of Science was held at Lancaster, Pa., in conjunction with the Pennsylvania Conference of College Physics Teachers and the Pennsylvania Junior Academy of Science, on Friday and Saturday, March 26 and 27. The meetings were all conducted on the campus of Franklin and Marshall College, President Thomas D. Cope, of the academy, ably presiding. The college and the Lancaster Branch of the American Association for the Advancement of Science were hosts. A total registration of 355 was recorded, including over 150 for the Junior Academy.

Friday was mainly devoted to the reading of papers before the academy. Thirty-six titles were presented, the distribution by subjects being as follows: Zoology 16, geology 10, botany 3, physics 2, education 2, miscellaneous 3. The Pennsylvania Conference of College Physics Teachers and the Junior Academy held independent sessions during Friday afternoon. At the former, thirteen, and at the latter, twenty-one titles were presented. The reading of the papers was supplemented by a number of exhibits and demonstrations, chiefly biological. There was a joint session of the academy and conference and guests on Saturday morning, at which seven invited papers were read. The sessions ended shortly after noon on Saturday.

Following the annual dinner on Friday evening at the Hotel Brunswick, the several organizations and guests assembled in Hensel Hall at the college to listen to the guest speaker for the annual academy lecture, Dr. F. R. Moulton, recently elected permanent secretary of the American Association for the Advancement of Science. Dr. Moulton chose for his subject "Science." He pointed out the present rapid growth of the value of applied science to human affairs and then indicated what a vast potentiality remains in this field for the future.

During the regular business meeting the following officers for 1937–38 were elected:

President: Dr. Geo. H. Ashley, state geologist of Pennsylvania.
Vice-President: Jaques Cattell, The Science Press.
Secretary: Dr. V. Earl Light, Lebanon Valley College.
Treasurer: Dr. C. W. Thurston, Pennsylvania State College.
Assistant Secretary: Charles E. Mohr, Reading Senior High School.
Editor: Ralph W. Stone, the Pennsylvania Topographic and Geologic Survey.
Press Secretary: Dr. Bradford Willard, the Pennsylvania Topographic and Geologic Survey.

The summer meeting for 1937 will be held at a date to be announced. It is planned to assemble at Wellsboro and visit Harrison State Park and the Coudersport ice mine. The regular annual meeting for 1938 is scheduled to be held at Bucknell College, Lewisburg, the date to be announced later.

The sessions just closed are considered to be among the most successful and best attended in the history of the academy. Much of this success is due to the efforts of the members of the Lancaster Branch of the American Association for the Advancement of Science and Franklin and Marshall College, particularly to Jaques Cattell, chairman of the Lancaster Branch and of the local committee on arrangements, and to Professors R. L. Charles and Howard M. Fry, of Franklin and Marshall College.

BRADFORD WILLARD,
Press Secretary

THE KANSAS ACADEMY OF SCIENCE[1]

THE Kansas Academy of Science was organized on September 1, 1868. For three years it was called the "State Natural History Society," but on October 25, 1871, the name was changed to the "Kansas Academy of Science." The society has held 68 annual meetings and has published 39 volumes of *Transactions*. These volumes comprise about 9,000 pages of printed matter, of which about 8,600 pages are devoted to scientific

[1] Report to the Annual Conference of the Academies, December 28, 1936.

reports and the other pages to reports of officers and business matters. Many of the papers report details of local plants, animals, insects and minerals, but a very large number are concerned with matters of general scientific interest, both theoretical and practical. The cost of publication, except for the years 1921–33, has been borne by state appropriation.

The academy had accumulated about 20,000 volumes of scientific magazines and books, largely by exchanges. Six years ago the academy allocated this library to three of the state schools. These institutions are cataloging and integrating the exchange journals into their libraries. By a system of mutual loaning, all books and periodicals are available to every one of the academy members from any one of the cooperating institutional libraries.

The annual meetings are held in odd years alternately at the State University at Lawrence and the State College at Manhattan and on even years at the various smaller colleges. The meetings are usually held a week after Easter and last from Thursday evening through Saturday afternoon. The evening meetings are given over to special lectures and the afternoons and parts of the forenoons to sectional meetings. The following sciences hold sectional meetings: Chemistry, physics, botany, zoology, entomology, psychology, medical sciences—bacteriology, physiology and anatomy and the Junior Academy.

In 1935, 150 papers were presented in the different sections and in 1936 meetings in a smaller college there were 120 papers. At the end of the 1936 session there were 430 members.

The Junior Academy has a number of very active clubs and holds an enthusiastic meeting on Friday afternoon. The organization of new clubs is being actively pushed by the academy. A special committee is handling this phase of the work.

A special committee has been appointed to study out the best plan of encouraging research work by the use of the research award of the American Association for the Advancement of Science. They are also finding ways and means to add to the amount of the award.

The committee on conservation of plants and animals is setting aside natural preserves in various parts of the state. It already has some "state parks" to its credit.

Another committee is working out a plan by which all the scientists of the state shall have some means of cooperating for the welfare of the state. It is hoped to create some kind of a super-council, a Kansas Association for the Advancement of Science, to include: The Kansas Engineering Society, the Kansas Horticultural Society, the Kansas Medical Association, the Kansas Dental Association, the Kansas Home Economics Association, the Kansas Mathematical Society (partly concerned with teaching), the Kansas Geological Society (partly commercial) and any others who are carrying on research or investigations. The Kansas delegate to the American Association for the Advancement of Science meeting is anxious to receive any and all suggestions for getting more cooperation among state scientists. It is believed that if the scientists of a state act as an aggregate they could add much to the efficiency of state governments and that they could often be of great benefit to each other and their respective societies.

W. J. BAUMGARTNER,
Delegate from Kansas Academy of Science

SPECIAL ARTICLES

TOXOPLASMA AND OBLIGATE INTRACELLULAR PARASITISM

TOXOPLASMA have been described as the causative agents of various pathologic conditions in birds and mammals, including man, in various parts of the world, but hitherto almost unnoticed in North America. The accidental isolation of toxoplasma early in 1935[1] in the course of experimental work with viruses has led to a study of these parasites by methods and procedures commonly used in virus work. The purpose of this communication is to call attention to some of the more striking results which were thus obtained, particularly their apparent obligate intracellular parasitism, and to indicate that as a result of this property these highly organized parasites (about $6\text{–}7 \times 3\text{–}4\ \mu$) have many features in common with certain ultramicroscopic viruses. Many of the problems encountered in the study of virus diseases, such as cultivation, pathogenesis, immunity, etc., are, to a great extent, influenced by the obligate intracellular "parasitism" which is an outstanding characteristic of the filtrable viruses.

In the course of tests for virus in guinea pig brains, two mice, injected intracerebrally, exhibited signs of encephalomyelitis nine days later, which proved not to be due to the virus under investigation. The disease was readily transmissible in series by intracerebral injection[2] of mice and was shown by extensive subsequent studies to be caused by a parasite which, in

[1] Toxoplasma were observed in guinea pigs in Mexico (H. Mooser, *J. Inf. Dis.*, 44: 186, 1929) and in birds of the Syracuse, N. Y., region, also in English sparrows kept in the laboratory and in canaries (R. D. Manwell and C. Herman, *J. Parasitol.*, 21: 415, 1935).

[2] All such operations were done with the aid of ether anesthesia.

morphology and in the wide range of hosts for which it proved pathogenic, corresponded closely to the as yet ill-defined group of Protozoa called *Toxoplasma*. Numerous investigations extending over the past two years have been made possible by proper preservation of the parasite, which, after many trials, consisted of storing an infected mouse brain in Tyrode's solution in the refrigerator for 14 days and then passaging it by intracerebral injection of mice. Fifty brain-to-brain passages have now been accomplished with the strain obtained from one of the original mice, and thirty-six with that from the other.

Our studies on the biology of these strains revealed that multiplication was possible only within living cells. The process consisted of penetration of the susceptible cell by the semilunar or piriform-shaped parasite and subsequent division by longitudinal fission. In the first two mouse passages after isolation both strains multiplied until they filled and distended the cells, leading usually to the ultimate extrusion of the nucleus and leaving structures consisting sometimes of hundreds of the parasites surrounded by the cell membrane and referred to by some as "cysts" or "pseudocysts." With the third intracerebral passage a spontaneous change occurred in one of the strains, whereby the invaded cells disintegrated when the total number of parasites in them was still quite small. This change was accompanied by a marked increase in pathogenicity that did not occur with the second strain until after about the twenty-fifth passage. In keeping with this observed intracellular parasitism, it was not surprising that they failed to multiply in media which did not contain living, susceptible tissue. Defibrinated blood did not support their growth. They could be cultivated, however, when minced chick embryo suspended in Tyrode's solution (the Li-Rivers medium, in which many viruses have been cultivated) was used. In this medium two series of six successful subcultures were carried out without loss of pathogenicity. The multiplication was found to occur within the cells. Concentrated, cell-free, Tyrode's solution extracts of chick embryo, inoculated for control, contained no living parasites even in the first culture, 4 days after incubation at 37° C.

The pathogenicity of our strains was studied in a number of different hosts. They produced fatal infections in mice, guinea pigs, rabbits and newly hatched and full-grown chickens; in *rhesus* monkeys a non-fatal disease was induced. Mice succumbed to infection when the parasites were given directly into the brain, into the peritoneal cavity, under the skin and even after instillation without trauma by way of the nose or mouth. With the increased pathogenicity acquired by passage, intracerebral injection in mice caused death within three to five days. The brain was always involved in mice, regardless of the route of inoculation, but pathological studies revealed that the distribution of the lesions was characteristically different after intracerebral and after peripheral inoculation. In the former instance the parasites were distributed by way of the cerebrospinal fluid and the lesions were situated chiefly periventricularly, at the base of the brain, and dorsally about the midbrain, while after peripheral inoculation the lesions were in the cerebral blood vessels and in the nerve cells surrounding them. The growth of the toxoplasma through the vessels, parasitizing cells of almost all the coats, and the subsequent perivascular nerve cell involvement were clearly apparent. Next to the brain the lungs were most constantly affected, while vascular organs, such as the kidney and liver, rarely showed any appreciable lesions, even though the parasites could be shown by animal inoculation to be present in the blood and all the organs.

It is not known how toxoplasmic infection is transmitted in nature. While an insect vector has been suspected, none has been identified or demonstrated. Our own experiments on contact infection among mice were entirely negative, until small numbers of starved animals were allowed to feed on others recently dead of the experimental disease. This suggests that at least one method of natural dissemination may be by means of the eating of toxoplasma-contaminated tissues.

Intracerebral inoculation in guinea pigs and rabbits led to fatal infection within four to six days, but the attack was chiefly on the meninges (dorsal as well as ventral). The distribution of nerve-cell lesions was directly beneath the meninges and almost not at all along the ventricles. Intracutaneous injection of the unchanged strain (*i.e.*, before the capacity of early disintegration of the parasitized cell was acquired) induced local skin lesions associated with systemic disease, but the rabbits always survived. After the spontaneous change occurred, more marked hemorrhagic and necrotic skin lesions ensued associated with systemic disease which invariably led to death of the animal within 8 to 12 days. A study of the pathogenesis of the latter disease revealed that the parasites were distributed to all the organs by way of the blood, but here again variations in the relative vulnerability of the viscera were apparent. As contrasted with the mouse, the rabbit brain showed little or no change, while the liver, spleen, adrenals, intestines and lungs were the seat of multiple focal lesions which in the gross, and even under the low power of the microscope, were almost indistinguishable in appearance and localization from the lesions of generalized vaccinia and certain other viruses. Under greater magnification one could see that the focal necrotic lesions were

due (1) to a growth through the vessels, *i.e.*, intracytoplasmic multiplication of the parasites and ultimate distintegration of the cells constituting their walls, with secondary involvement of the parenchymal cells by the parasites, and (2) to thrombosis of involved blood vessels with secondary necrosis of parenchymal cells without preliminary parasitization. The kidneys were again, strangely enough, only irregularly affected, and even then only the interstitial vessels seemed to suffer while the glomeruli and tubules appeared almost uninvolved. The destruction of cells either directly by the parasites or indirectly by thrombosis of blood vessels whose walls were parasitized comprised the outstanding pathological changes, while inflammation was either absent or, in certain instances, a late manifestation.

Intracerebral inoculation in *rhesus* monkeys was followed only by a febrile disease. Intracutaneous injection gave rise to a local lesion associated, as after other forms of peripheral inoculation, with systemic disease and the presence of the parasites in the circulating blood, as demonstrated by mouse inoculation.

The toxoplasma also appear to offer an opportunity for direct investigation of certain as yet obscure problems in immunity of obligate intracellular parasites. It has been possible to show, for example, that *rhesus* monkeys recovering from an infection with toxoplasma are immune to reinoculation and that the serum of such monkeys contains antibodies which may be termed "neutralizing" or "protective." The "neutralization" or "protection" tests were performed in the same manner as with viruses, *i.e.*, by mixing *in vitro* the serum with a tissue suspension or exudate containing the parasites and injecting the mixture intracerebrally or intraperitoneally in mice or intracutaneously in rabbits. The latter proved to be the method of choice, since the parasite suspension as well as a number of different sera could all be titrated quantitatively on the back of one rabbit. It was interesting, however, that rabbits which recovered from the non-fatal disease induced by the intracutaneous injection of the "unchanged" toxoplasma developed a solid tissue immunity resisting the constantly fatal intracerebral injection of the same strain, as well as inoculations with the highly pathogenic and fatal changed strain, but, as a rule, had no demonstrable protective humoral antibodies. In some rabbits only sufficient antibody to protect against a single skin infective dose was present. Similar observations are not uncommon with certain viruses.

Preliminary studies on the protective antibody in convalescent monkey sera revealed that it apparently had no effect on the toxoplasma *in vitro*. No agglutination or disintegration of the parasites could be observed in mixtures which proved innocuous on animal inoculation. Centrifugation of such mixtures after incubation for several hours *in vitro* and separation of the parasites from the serum showed that they had retained their infectivity. Further studies now in progress on the nature of this protective antibody, as well as the solid tissue immunity unassociated with such antibodies, are expected to yield data of interest to the understanding of similar phenomena with other obligate intracellular parasites.

The rabbit skin protection test may, perhaps, also prove useful in the diagnosis of infection with toxoplasma. The present evidence that they cause disease in man is rather tenuous and has been questioned by many competent parasitologists. The reason for this uncertainty is that the diagnosis has been based either entirely on morphological grounds without tests for pathogenicity or only on animal inoculation. In a recent study[8] on glandular fever (infectious mononucleosis) doubt arose as to whether the toxoplasma which were isolated were derived from the patients' blood or from the experimental animals (rabbits) which might have been spontaneously infected. The protection test just described might aid in elucidating this problem.

The work just outlined will be described in detail in a future communication. The aim of the present report is primarily to call attention to the existence of toxoplasma in North America and to point out their obligate intracellular parasitism, a study of which reveals many features in common with certain of the filtrable viruses, particularly as regards pathogenesis, cultivation, immunity and other host-parasite relationships.

ALBERT B. SABIN
PETER K. OLITSKY
THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH
NEW YORK, N. Y.

HEPARIN AND THE FORMATION OF WHITE THROMBI

IN a recent preliminary communication Murray, Jaques, Perrett and Best[1] reported that the incidence of thrombus formation after mechanical or chemical injury to veins was appreciably decreased when a solution of purified heparin was administered to the dogs before and for adequate periods after the injury. In animals which did not receive heparin the injury was followed by the appearance of typical thrombi. Areas exhibiting the structure of thrombi could be observed in many of the histological sections made through the obstructing mass. Since the veins from the heparinized animals were in many cases free of obstruction,

[8] J. O. W. Bland, *Lancet*, 2: 521, 1930; *Brit. Jour. Exp. Path.*, 12: 311, 1931.

[1] D. W. G. Murray, L. B. Jaques, T. S. Perrett and C. H. Best, *Can. Med. Assoc. Jour.*, 35: 621, 1936.

it would appear that adequate amounts of heparin are effective in preventing the accumulation of platelet masses on the injured surfaces of veins.

The opinion has been wide-spread, however, probably largely as a result of a publication of Shionoya, that while heparin prevents the clotting process it does not influence the deposition of platelets. Rowntree and Shionoya[2] studied the accumulation of platelets in an "extracorporeal loop." Using this technique, Shionoya[3] reported that heparin had no influence upon the rate of formation of white thrombi.

We have repeated the experiments of Shionoya and find that in dogs when the observations are made over a two- or three-hour period, there is almost invariably formation of white thrombi in the glass cannulae and the collodion or Cellophane tube used to connect the arterial with the venous cannula. Masses of white thrombi, large enough to produce partial or complete obstruction of the tubes, have been observed in 15 of the 16 experiments in which no heparin was used. In experiments, however, in which one intravenous injection of a solution of purified heparin (450 units per kilogram) was made, we have never observed any obstruction of blood flow or the accumulation of any platelet masses.

Microscopic examination of the obstructing masses in the experiments in which heparin was not used revealed, in every case, the typical structure of the white thrombus. In all except two of the experiments in which heparin was used microscopic examination of the Cellophane loop revealed only a few red and white blood cells. In two cases *very minute patches* of material which appeared to be composed of platelets were seen. It may be stated, however, that in no case was any mass which had the characteristic structure of a thrombus observed in the experiments in which heparin was administered.

The results of these studies demonstrate that purified heparin is very effective in preventing the formation of white thrombi under the conditions of our experiments.

C. H. BEST
CAMPBELL COWAN
D. L. MACLEAN

THE SCHOOL OF HYGIENE
UNIVERSITY OF TORONTO
TORONTO, CANADA

LIGHT AND THE SEXUAL CYCLE OF GAME BIRDS

SINCE Rowan's[1] original observations that lengthening the period of light in winter by means of artificial illumination caused stimulation of normally quiescent gonads in juncoes, similar results have been found in other species of birds and some mammals.

As a result of night lighting of upland game birds, Petty[2] secured gonad stimulation and eggs in quail during the non-breeding season in 1934, Martin[3] announced mid-winter production of eggs in pheasants (*Phasianus colchicus torquatus*) in 1935, Clark, Leonard and Bump[4] secured gonad stimulation in pheasants, quail and grouse (*Bonasa umbellus*) and Bissonnette and Csech[5] secured early eggs from pheasants and quail by night lighting.

We wish to report briefly some of our experiments concerning the factors regulating sexual activity in the pheasant and grouse.

(1) The absence of light inhibits the onset of sexual activity in the grouse and pheasant. Two pair of grouse were continuously in the dark, except for a low illumination of 0.02 foot candles over the feeder from February 10 to June 20, 1936. No sexual activity was manifested during this time, although the experiment extended over the period of sexual activity of the control birds. Two pair of pheasants under the same experimental conditions also failed to come into breeding.

(2) Continuous illumination during the winter months can stimulate grouse into sexual activity and egg laying but does not prevent the cessation of egg laying. A pair of grouse were illuminated continuously, starting on February 10, by two 150 watt lamps. No daylight was admitted and the light intensity was maintained constantly at 22 foot candles. Egg laying began on March 6 and continued to April 3, yielding 14 eggs, the normal number for grouse. None of the control grouse laid before April 10. The experimental birds ceased laying in spite of the continued light. We were able to secure egg production prematurely in pheasants and quail with night light, but did not carry the experiment to the end of the normal breeding season.

(3) The cessation of egg laying is probably due to a failure of the hypophysis to furnish the necessary gonad stimulating hormones rather than to an exhaustion of the gonads. On June 23, 1936, two pair of grouse which had completed their reproductive cycle were autopsied, and it was found that the sex organs had regressed to approximately the mid-winter condition. The testes of the males weighed 41.4 and 41.6

2 L. G. Rowntree and T. Shionoya, *Jour. Exper. Med.*, 46: 7, 1927.
3 T. Shionoya, *Jour. Exper. Med.*, 46: 19, 1927.
1 W. Rowan, *Nature* (London), 115: 494–495, 1925.
2 *American Field*, August 11, 1934.
3 L. E. Martin, *Game Breeder and Sportsman*, 39: 95, April, 1935.
4 L. B. Clark, S. L. Leonard and G. Bump, SCIENCE, 83: 2150, 268, March 13, 1936.
5 T. H. Bissonnette and A. G. Csech, SCIENCE, 83: 2156, 392, April 24, 1936.

mgs, as compared to 27.3 mg for the testes of a male autopsied in January of the same year. The ovaries weighed 126.8 and 110.3 mgs, as compared to 56.7 mg for the ovaries of a bird killed in mid-winter. The injections of 5 to 10 grams equivalent of an alkaline hypophyseal[6] extract in 3 male grouse for 10 days resulted in testes weighing 238.2, 206.4 and 179.4 mgs, an increase of approximately five times.

Similar results were found in the pheasants. The testes of 3 male pheasants autopsied on August 3, 1936, three weeks after the close of the breeding season, weighed 367.8, 617.1 and 612.5 mgs. The testes of birds in the winter weighed from 69.7 to 164 mgs, while in full sexual activity they weighed over 6 grams. Three male pheasants, each receiving a pyridine extract of sheep hypophysis equivalent to 5 grams of dried glands for a period of 10 days, yielded testes weighing 1,232, 2,209 and 3,001 mgs, as compared to 907 and 1,052 mgs for two uninjected controls. The difference in weight of the testes of the controls and those autopsied August 3 is due to the fact that they belong to different age groups. The average increase was 119 per cent.

In both grouse and pheasant, histological examination of the testes confirmed the gross observations. In all injected birds, the testes showed mitotic activity, an increase in the number of cells in the germinal epithelium and an enlargement of the tubules. Normal sperm were found in the largest testes of the injected pheasant; none were found in the controls. The control testes of both pheasant and grouse gave evidence of degenerating to the resting condition, the grouse testis having regressed further.

(4) The gonads of immature pheasants will respond to adequate hypophyseal stimulation. A group of 8-week-old male pheasants were given a similar amount of the sheep hypophyseal extract for the same period as the adult pheasants. The testes of the young injected birds weighed 197.0, 143.3 and 93.2 mgs, and the testes of the controls weighed 61.2, 45.2 and 67.8 mgs, an average increase of 148 per cent. Microscopically, the stimulated testes were easily distinguished by the enlargement of the tubules and the increased number of division figures in the germinal epithelium.

SUMMARY

The results of these experiments has led us to conclude that light is a primary factor in inducing sexual activity in pheasants, quail and grouse, through the mediation of the hypophysis. Once this hypophyseal-gonad reaction is started it can not continue indefinitely with adequate light but only until the hypophysis falters in the production of the gonad-stimulating hormone through causes unknown. The immature pheasant resembles the adult at the close of the breeding season in that the gonads are capable of responding to adequate hypophyseal stimulation.[7]

LEONARD B. CLARK
SAMUEL L. LEONARD
GARDINER BUMP

DEPARTMENT OF BIOLOGY
UNION COLLEGE, SCHENECTADY, N. Y.
AND
EXPERIMENTAL GAME FARM
N. Y. STATE CONSERVATION DEPARTMENT
DELMAR, N. Y.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE PHOTOELECTRIC DETERMINATION OF PHOSPHORUS IN ESTUARINE WATERS

IN estuarine waters there is much variation in salinity and heavy metal content, both of which factors may interfere with phosphorus determination, when the Denigès method is followed. Errors due to such factors must be taken into consideration. Also, the blue color of the reduced phospho-molybdate, as produced in the Denigès method, may be of improper magnitude (intensity and quality) for comparison with a standard blue solution by means of an ordinary comparison colorimeter. Accordingly, a photoelectric colorimeter was devised to study the color production.

A Weston photometer measuring light intensity in foot candles, a ruby glass filter, a pyrex tube 30 cm long closed at both ends to hold the solution and a Spencer microscope lamp served as the photoelectric colorimeter. The solution to be tested, which was blue in color after being treated according to the Denigès method, was put into the 30 cm pyrex tube, in the ends of which plane glass pyrex windows were fused. An opening left on the side of the tube served for filling and emptying. By placing such a cylinder, filled with the blue solution to be tested, in the path of the beam of light, the absorption of the light by the solution expressed in terms of change in light intensity would be measured by the galvanometer of a light-sensitive instrument, such as the Weston photometer, at the other end. The ruby glass filter which transmitted only a narrow band of red (an average wavelength of 6,500 Å) was used because in the region of the band mentioned there was a maximum change in

[6] Acknowledgment is made to Parke Davis Company for their kindness in furnishing the hypophyseal glands.

[7] Research supported in part by assistance of grant-in-aid of the Society of Sigma Xi and the Rockefeller Foundation.

light transmission with the changing concentration of blue coloring matter and hence maximum sensitivity. Briefly, the purpose was to measure light intensity in that region of the spectrum where the greatest changes in magnitude occurred, irrespective of the color.[1]

From the data obtained by this method, calibration curves for the salinities ranging from 0 o/oo to 30 o/oo (30 gms of salts per 1,000 ml of water) with 5 o/oo increments were constructed. An artificial sea water suggested by Buch was used, in which NaCl, K_2SO_4 and $MgCl_2$ of the highest purity (almost free from phosphorus) were dissolved in water redistilled in a pyrex still. Such water was practically free from phosphorus. Pure KH_2PO_4 was added to these solutions to make them of concentrations of phosphorus ranging from 0 mg P/m^3 to 100 mg P/m^3 (100 milligrams of phosphorus per cubic meter of water).

Calibration curves, which deviated only slightly from straight lines, were made by plotting as ordinates the logarithm of the photometer reading on semi-log paper, against the concentration of phosphorus in milligrams per cubic meter as abscissae. By observing the point on the calibration curve corresponding to the photometer reading obtained for a test, the phosphorus content may be read off on the abscissa. Such curves have been found satisfactory, because known amounts of phosphorus added to the test solution have been recovered with small error, indicating that the curve and method are satisfactory and reasonably accurate. Table 1 shows the recovery

TABLE 1

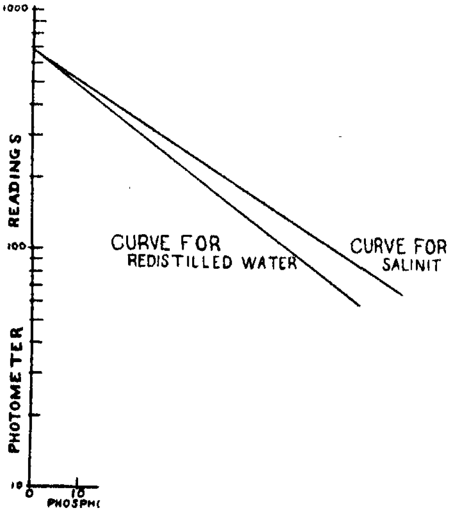
Inorganic phosphorus present in water sample	Inorganic phosphorus added	Total inorganic phosphorus expected	Total inorganic phosphorus recovered
mg P/m^3	mg P/m^3	mg P/m^3	mg P/m^3
18	0	18	18
18	10	28	28
18	20	38	40
18	30	48	50
18	80	98	96
9	0	9	9
9	10	19	18
9	20	29	30
9	30	39	39
9	80	89	94

of added phosphorus, in milligrams per cubic meter, ·om Chesapeake Bay water of an approximate salin- 15 o/oo (first group of figures) and from the · diluted one half with redistilled water p of figures). Due to the use of the the sensitivity and accuracy of the tly increased, especially in the lower hosphorus, as can be seen from the

on the authors are pleased to ac- by Professor A. H. Pfund, of the Johns Hopkins University, in absorption

fact that one milligram of phosphorus corresponds to forty divisions on the photometer scale.

The question of the effect of salts on color production needs consideration, since the samples to be tested are saline solutions. A study of the curve for redistilled water as compared with the curves for artificial sea water shows the former to have a steeper slope than the latter, which means that the salts in the water decrease the amount of color. The slope of the curves for artificial sea water were found to decrease a little for the salinities studied, *i.e.*, from 5 o/oo to 30 o/oo. This shows that for the salinities of 5 o/oo to 30 o/oo the effect of the salts on the color production is small, *i.e.*, there is only a small increasing effect with the increasing salinity in the range tested. In fact, an average curve for salinity from 5 o/oo to 30 o/oo and phosphorus content from 0 to 100 milligrams per cubi meter has given results accurate enough for our pu poses. But the salt effect or decrease in color due the presence of salts is considerable when compa with the color in redistilled water. This is readily from the curves (see Fig. 1).



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made for salinity and other interfering substances if calibration curves are used because these interfering factors with one exception, that of arsenic, are taken care of in the preparation of the curves. Arsenic, if present as arsenate, and phosphorus are determined together in the Denigès method, so it is necessary to evaluate the arsenate by suitable means if true phosphorus values are to be obtained.

Farber and Youngberg[2] have shown that with the Denigès[3] method, copper, iron and sulfates do not interfere with the color production in phosphorus determinations if appropriate amounts of reagents are used. Cooper[4] has recognized that there is an interfering effect of the salts present in sea water. Brujewicz[5] gives tables of correction for various salinities, showing that the latter have an effect on color production, and he evaluates a corresponding factor. Kalle,[6] on the other hand, maintains that in the true sense of e word there is no salt error, but that the effect tained is due rather to the copper present in the sea er. Using the same instrument as Kalle, Robinson Wirth[7] found a decided decrease in color intensity o the presence of salts. Our results show that 's decided salt effect from redistilled water to a ' of 5 o/oo, but that this effect increases only a nount from this point to 30 o/oo salinity. Also, ment with Farber and Youngberg, copper and 'ie magnitudes tested have no effect on color '.

CHARLES E. BRAMBEL
R. P. COWLES
HOPKINS UNIVERSITY AND
··KE BIOLOGICAL LABORATORY

··G FUNGI FROM ATION[1]

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time, has been used successfully to free a number of water molds from their bacterial contaminants.

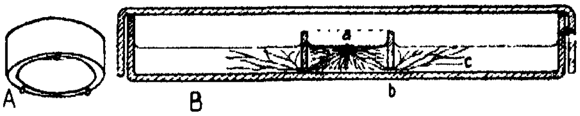

FIG. 1

To one end of a Van Teighem ring are fused three small glass beads, one third to one half mm in diameter, as shown in A of the accompanying diagram. The ring is placed in a Petri dish with the beaded surface resting on the bottom of the dish. Into the Petri dish enough nutrient agar (2 per cent. agar plus some suitable nutrient) is poured to bring its surface well up on the sides of the ring as in B. After the agar has solidified, a bit of inoculum is transferred to the area within the ring (*a*). As growth takes place some of the hyphae extend down into the agar, grow under the ring (b) and into the agar lying beyond it; the contaminating bacteria, however, do not follow the hyphae but are retained at the surface of the semi-solid within the ring. Cubes of agar containing numerous hyphal tips from this outlying portion of the mycelium (c) are therefore bacteria free; from these it is simple to start fresh cultures perfectly free from contamination.

This method has been used so far only for the purpose of freeing water molds from bacteria, but it should prove equally effective in securing pure cultures of any fungus which does not form an aerial mycelium. It is described here in the hope that it may be of use to other students working with such forms.

JOHN R. RAPER
UNIVERSITY OF NORTH CAROLINA

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ome beverage alcohols. The lethal concentration in the blood is the same for all we have tested, but there is considerable difference as between alcohol from various sources in the dose required to produce this concentration, a fact suggesting a difference in the rate of oxidation.

Our observation that the concentration of blood sugar influences the pharmacological effects of alcohol may offer some explanation of the alleged idiosyncrasies in human reactions to alcohol. It affords a new factor that must be taken into consideration in any experimental study of the pharmacology of alcohol. Our technique of determining doses under conditions of equilibrium affords a method of making precise quantitative measurement of the toxicity of alcohols from various sources.

HOWARD W. HAGGARD
LEON A. GREENBERG

YALE UNIVERSITY

THE OPERCULAR APPROACH TO THE PITUITARY[1]

SURGICAL techniques for the removal of the pituitary gland of teleosts have been described by Parker[2] in the catfish, *Ameiurus,* and by Matthews[3] in the killifish, *Fundulus.* These techniques are not quite satisfactory in experiments to be carried on over long periods of time, inasmuch as the operated animals survived only for a short time; the catfish surviving only two days, and the killifish several weeks. A new approach to the teleost hypophysis whereby tissue injury is reduced to a minimum has been worked out by the author with more satisfactory results.

(1) THE CATFISH

Parker's method of hypophysectomy consisted in making a U-shaped cut through the gular membrane from the opercular opening on one side to that on the opposite side of the animal, so that the lower jaw was completely separated from the gills. Having accomplished this initial opening, the operation was completed by puncturing a hole in the parasphenoid and sniping off the gland. This method involves a two-inch incision which may be avoided in the following manner. The catfish is wrapped in a wet cloth and placed on its back under a binocular microscope. The mouth is held open by five retractors, and an incision about two to three millimeters in length is made through the mucous membrane covering the parasphenoid bone. A trephine drill is then introduced under the operculum and between the first and second gill arches. One merely lifts the operculum and gently separates the first from the second gill arch. This procedure exposes a wide natural cavity, and the drill may now be inserted directly perpendicular to the roof of the mouth. The hypophysis can be seen through the bone as a small yellow spot. A hole (1.5 mm in diameter) is drilled through the bone, the gland sucked up in a pipette, and the wound closed by a single suture through the mucous membrane. The operation can be performed virtually without the loss of a single drop of blood and need not take over three minutes. The animal is returned to a tank of running tap water and survives for many months. Within a week, the suture disappears and the cut membrane heals over completely.

(2) THE KILLIFISH

Matthews's method of hypophysectomy involved a sub-oral route, since he first made a V-shaped incision through the branchiostegal membrane with the base of the V at the tip of the tongue. The tongue was then pulled sufficiently ventral to expose the region of the pituitary. My operations with the sub-oral route proved unsatisfactory mainly because of the size of the initial incision, and the necessary cutting of a large blood vessel running along the ventral surface of the lower jaw. These two difficulties may be avoided by the opercular approach. The fish, first immobilized by immersion in cracked ice, is placed on its left side under an operating microscope. The operculum is elevated and held by a single retractor. The first and second gill arches are separated, thus exposing a wide space directly below which the hypophysis is located. A three-millimeter incision is made through the epithelial membrane slightly lateral to the mid-line in order to avoid a median artery. A hole is drilled with a trephine drill (1 mm in diameter) and the gland sucked up in a pipette. The wound is not closed by a suture because of the proximity of the median artery, but the circular piece of bone excised by the drill may be replaced to close the wound. The operation may be performed within five minutes and if done with sufficient care is a totally bloodless operation. The animal is placed in salt water for a day and then transferred to running tap water, as Matthews recommends, or it may be placed directly in tap water at room temperature.

This approach to the pituitary gland under the operculum and between the first and second gill arches may prove satisfactory for other teleost fishes.[4]

A. A. ABRAMOWITZ

BIOLOGICAL LABORATORIES
HARVARD UNIVERSITY

[1] Aided in part by a grant from the National Research Council Committee on Problems of Sex administered by F. L. Hisaw.

[2] G. H. Parker, *Jour. Exp. Zool.*, 69: 199, 1934.

[3] S. A. Matthews, *Biol. Bull.*, 64: 315, 1933.

[4] Smith, Burr and Ferguson (*Endocrin.*, 19: 409, 1935), describe an orbital approach for hypophysectomy in the goldfish. These authors state, however, that their operative procedure involves enucleation of the right eye, severe traumatization of the interorbital plates, invariable rupture of an artery, blind groping for the hypophysis, traumatization of the hypothalamus and successful extirpation in one of seventeen cases.

THE APPLICATION OF SPRAYS TO EXPANDING PLANT SURFACES[1]

DURING the season of 1934, the authors had occasion to make a series of measurements of the surface areas of apple fruits grown in the college orchard at State College, Pa. This work was done in connection with a study of the deposition and retention of lead and arsenic trioxide on the fruit and leaf surfaces of two varieties of apples sprayed with three spray mixtures. From these measurements and from the chemical analyses of the fruit surfaces for the two toxic elements, it was apparent that the expansion of the fruit surfaces during growth was the most important single factor operating against the maintenance of an adequate deposit for the control of chewing insects, particularly the codling moth (*Carpocapsa pomonella* L.). The effect of the growth was particularly great during the early period of development of the fruit, when the surface areas doubled in extent within four or five days. It was reasoned from this work that spray applications would be more effective in maintaining an adequate deposit if the early sprays were applied at more frequent intervals, thus compensating for this rapid increase.

During the season of 1935 ten Stayman Winesap trees in the college orchard were sprayed with a mixture containing lead arsenate 3 pounds, flotation (wettable) sulfur 5 pounds and fish oil 1 quart per 100 gallons of spray mixture. On five of the trees three applications were made at regular intervals of 14 days. On the remaining five trees applications were made at intervals of 4, 10 and 20 days following the first application. Samples of fruit were taken for chemical analyses immediately previous to and following each spray application. More extended measurements of growth rate of fruit of this and other varieties were also taken during this season, from fruit at the tops of the trees as well as from the lower limbs. Study of the results of this experiment led to the following conclusions:

(1) Growth of the fruit at the tops of the trees was considerably more rapid during the greater part of the season than of those at the bottom.

(2) Fruit from the tops of trees of the Stayman Winesap variety increased from 300 square millimeters in area to 950 square millimeters within ten days (between June 1 and June 10). The subsequent increases were progressively less rapid.

(3) In order to provide an adequate deposit on the fruit surfaces during this early period the second cover spray application should follow the first by not more than 5 days. The third application should follow the second by not more than 9 days, while between the third and fourth applications 13 days may elapse. Under conditions of heavy codling moth attack a fifth spray may be necessary, in which case an application 17 days after the fourth should serve to maintain a deposit adequate for protection until early in August.

While the results given above apply only to central Pennsylvania conditions and the details of the method and dates of application may vary with the locality, it is felt that such timing of spray applications is of sufficient importance from an economic and practical point of view to merit consideration by all workers who have to deal with the problem of insect control on materials of this type. The complete results will be published in the near future.

D. E. H. FREAR
H. N. WORTHLEY

[1] Authorized for publication on January 26, 1937, as Paper No. 760 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

ON THE STRUCTURE OF PECTIN POLYGALACTURONIC ACID

THE fundamental problem of the structure of an oligopolysaccharide consists in elucidation of the places of union of each monose to the other and in the elucidation of the ring structure of each monose. In the special case of the pectin polygalacturonic acid, this information was lacking. We have now succeeded in demonstrating that carbon atoms 4 and 5 are engaged in the ring formation and in the condensation of each unit with its neighboring unit.

This information was obtained by degradation of the polygalacturonic acid with periodic acid which resulted in the formation of levotartaric acid which has been identified as its acid potassium salt.

For $C_4H_5O_6K$, K = 20.78 per cent.; Found K = 20.70 per cent.

$$[\alpha]_D^{25} = -22.0° \text{ (in water)}$$

and for the undissociated acid,

$$[\alpha]_D^{25} = -15.0°.$$

The special function of the hydroxyl groups of each of the carbon atoms 4 and 5 remains to be established. However, it is safe to predict that the hydroxyl group of carbon atom 4 serves for condensation and that of carbon atom 5 for ring formation.

P. A. LEVENE
LEONARD C. KREIDER

ROCKEFELLER INSTITUTE FOR
MEDICAL RESEARCH, NEW YORK

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THE SPIRIT OF THE LABORATORY[1]

By Professor CHARLES R. STOCKARD

CORNELL UNIVERSITY MEDICAL COLLEGE, NEW YORK, N. Y.

WHY do we build a laboratory for physiological research? Because there have lived men like Theobald Smith. The discoveries and scientific advances made by such men have continually necessitated the building of new laboratories with more and more refined facilities in which other investigators might work to further widen the horizons of knowledge. Naming this the Theobald Smith Laboratory is dedicating it to one of the persons who greatly aided in its building. The Albany Medical College is to be congratulated on the realization of this fact, as well as on its peculiar right to adorn the building with such a name! Theobald Smith was a native son of this city, and the most distinguished graduate of the Albany Medical College. And it should be added, he probably was the most eminent contributor to medical science that this country has produced.

We may venture the fanciful conjecture that the earliest laboratory for physiological research was the Garden of Eden. Wherever this was, the story suggests that Adam tried out the effects of different plants as food for the human body and mind. These early instinctive experiments are still being performed by almost all members of the animal kingdom. But of all the animals, only Adam, with the valuable assistance of Eve, finally discovered the tree of knowledge and ate of its fruit. This food nourished the mind of Adam to develop beyond that of other animals, and he was driven out of the Garden and became capable of earning his bread by the sweat of his brow. The descendants of Adam ever since have been searching for this lost tree of knowledge, and though they have failed to find it they have learned much from the

[1] Address given at the dedication of the Theobald Smith Memorial Laboratory at Albany Medical College on March 19, 1937.

search. We are proud that the human race has gone a long way from the Garden of Eden, at least in some directions, and so to-day we are dedicating the latest laboratory for physiological research and teaching. However, the same old problem of the actions of foods and chemical substances on the functions of the animal body and mind is still the paramount issue to be studied.

What is meant at the present time by physiological research? Does this embrace a wide realm or a special field of study? Physiological research is the investigation of the functions and behaviors of all living arrangements: it includes investigations of the manner in which the ultimate life units or organic molecules exist with the power to induce the formation and multiplication of other units like themselves from the elements of their restricted environments. This power of self-synthesis is the fundamental feature of life. Physiological research includes studies of the genes within the chromosomes and their behavior in determining the constitution and the characters of the individual; it must reveal the miraculous processes by which the egg is changed into a fully formed child; it embraces considerations of the growth and differentiations which transform the child into manhood, as well as the actions and interactions of the organs, tissues and fluids of the adult body in maintaining its normal state; and finally, physiological research must include the study of the mysterious ways in which some arrangements within the brain give rise to consciousness and intelligence. Each and all these riddles are to be solved by physiological research founded on a sound background of morphology and allied sciences. The laboratory we are dedicating to-day will surely never have its activities restrained by the narrowness of its field for investigation. The subjects for study in this laboratory may actually include the behaviors of the investigators themselves.

The impulse to do research in its simplest form is a deep-rooted instinct. All young animals, including our own children, are curious and restless to become acquainted with their environments; this is a phase of the subconscious instinct for self-preservation. The desire to understand functions and behaviors is probably more nearly instinctive than is the interest in other classes of knowledge. From this supposition we need not infer that physiologists are necessarily more primitively minded than other persons.

The child's impulse to investigate its surroundings and learn about things is short-lived and is usually discouraged in most individuals during their stay in schools. It therefore becomes the primary necessity of a laboratory to create an atmosphere which will reawaken, stimulate and perpetuate the natural curiosity to learn, and thus promote the spirit for scientific investigation. The stimulus to do highly developed scientific research comes not alone from the essential "spark" within the investigator, but also from the inspiring spirit of the laboratory which fans this spark to its brightest glow. The laboratory must be invaded by that shy and intangible spirit which inspires enthusiasm and creates the devotion to research.

In building a new laboratory we have in mind two objectives. The one is material—a physical arrangement in which men may work and learn. Constructing such a plan is an ordinary accomplishment. Numbers of laboratories have been built in this country and in all parts of the world during the past few decades. Many of these structures are simple and modest, and others are elaborate and extravagant in both building and equipment. There is a broad possibility that modest buildings may well suffice for scientific work. The ingenuity of the investigator is not promoted by completely ready-made facilities. Discoveries of great scientific importance rarely if ever have come from palaces, but almost always from very simple surroundings. Few discoveries have been so fundamental in the advance of modern biology as the laws of heredity discovered by the monk, Gregor Mendel, in his monastery garden. The deductions which Darwin drew from studies made at his modest estate in England revolutionized the thinking of the intelligent world. Theobald Smith's discovery of the intermediate host in infectious disease and Walter Reed's experiments with yellow fever required very simple housing. Throughout the periods of history, monumental buildings stand more as final accomplishments than as markers of the beginnings of progress. In universities there has often been an exaggerated contrast between the grandeur of the laboratory buildings and the cramped conditions under which the family of an able scientist must live.

Solely from the standpoint of a new building for a laboratory there is little cause for rejoicing. But from the standpoint of the other element concerned in the creation of this building there is reason for great acclaim and enthusiasm. You intend not only to have the building, but you have proposed at its very beginning to induct into this laboratory the spirit of Theobald Smith. In so doing you have planned more wisely than you may know.

The creative spirit is the element most difficult to obtain and for that reason so often lacking within the atmosphere of laboratories. It has seemed to me appropriate, therefore, to devote my brief remarks on this occasion to that very strange thing—the spirit of the laboratory.

What do we mean by the spirit of the laboratory? Whence does it come, and how is it obtained? A

direct answer to these questions is almost impossible to give. However, we may consider them with some profit. Spirits are hazy things to describe. Their presence is realized by an appreciation of something in the environment that is not readily analyzable from the background of experience with our senses. A tour of several laboratories in different parts of the world may convey to you an idea of the thing which we hope is being introduced into this laboratory.

Some years ago there was established a tropical laboratory of marine biology on a small and isolated island in the Gulf of Mexico. The buildings were modest wooden shacks, and a small group of biologists were invited by the director to work in them. The workers slept in quarters adjoining the laboratory and ate in the same room that housed the aquarium. The temperature and humidity were uniformly high. Almost every piece of apparatus used was more or less improvised. Yet in the crudeness of this laboratory an inspiring spirit was present. Every one worked from dawn until darkness with a sense of joy in the doing.

The laboratory was new and without tradition or prestige; it was an affiliated part of the then new Carnegie Institution. Yet in spite of this newness, here was an atmosphere and a spirit that was quite inspiring and one continued to be enthused by this inspiration after years of absence from the place. The spirit emanated from the director, a simple, unassuming and unselfish person who made all feel that the laboratory would benefit greatly from their presence. The association was intimate, and the philosophy of the director peculiarly stimulating.

In the laboratories for marine biology built long ago by Anton Dohrn at Naples, there has been a spirit of inspiration from the start which has lasted for sixty years. Much of the history of modern biology might be written around this laboratory. Here Loeb started his studies in general physiology, and Wenckebach as a young student first observed the living development of the heart and vessels, and Wilson and Morgan and Driesch and many others did much to stimulate the early days of experimental embryology. Dohrn introduced a spirit, and a long line of workers in the same environment have kept it alive. The spirit here has not been due alone to one man but to the freedom of the place and the association of the workers.

The Marine Biological Laboratory at Woods Hole, which has been the great disseminator of enthusiasm for general biology and physiology in this country, is a prize locality for observations on the spirit of the laboratory. For years this laboratory had only the most primitive wooden buildings and little equipment. But the spirit was inspiring and the ingenuity of the investigators more than compensated for the inadequacy of apparatus. The high position which America holds in the field of experimental biology rests very largely on Woods Hole. The laboratory buildings are now all that could be desired, with modern equipment and apparatus. But the spirit and manner of the place have remained the same, as nearly as a large place can possess the properties of a small. The spirit at Woods Hole comes from many persons working together in free association. It is a scientific democracy and the "director" neither dominates nor directs. At the opening of one of the new laboratories Mr. Charles R. Crane, a wise benefactor, remarked that the most valuable element of these laboratories was the spirit that had existed within them. Presidents of universities and directors of various laboratories have come to Woods Hole to learn what makes the spirit here. They hoped to catch such spirit for their own institutions. Mr. Crane's wish was that the spirit would not shy away from the new buildings but would remain to find in them an agreeable home.

The laboratories thus far mentioned are peculiar in that the investigators working in them are not employed to do research. These persons come on their own account for the opportunity to work, and their relationships and associations are different in ways from those of members of a laboratory staff. Yet the rare spirit we are pursuing does not always dwell even in laboratories of this type. There are some such laboratories in which the true spirit of research has never been expressed, though able investigators may have worked in them.

We turn now to laboratories closer to the kind being dedicated to-day: the scientific laboratories in the departments of the medical faculty in universities. Some years ago in the German university at Munich one of the scientific departments was housed in the most perfect physical plant that any institute of this particular kind then possessed. The building and its arrangements were famed throughout the world. There was a large staff and much activity, but the atmosphere was not inspiring and the spirit of research was weak and sickly. The soul was absent. Another biological laboratory in this university was located a short distance away in an old and dilapidated building. The staff was smaller. But the spirit of inspiration in this laboratory was so great that students came from all parts of the world to be stimulated by it. The spirit here seemed to radiate from a small, simple man with a proud but kindly interest in the scientific investigations of all students. He knew all the investigators who visited his laboratory and encouraged every one with scholarly enthusiasm.

The spirit of scientific research has flourished in an unusually conspicuous manner in the small Bavarian

University of Würzburg. Here in the ancient anatomical pavilion in the garden of the Julius-Spital, Albert von Kölliker at thirty years of age began, as professor of anatomy and physiology, to lay the foundation and build almost the entire subject of modern histology, and to add much to the physiology of the tissues. In this same pavilion Rudolph von Virchow, while in his thirties, developed the field of cellular pathology. Kölliker moved into a new and larger laboratory of anatomy, where his studies continued to rapidly expand, outgrowing this second laboratory, which was later used as an institute of hygiene. The third anatomical institute occupied by Kölliker still serves as a splendid laboratory of anatomy which after him has been directed by Stöhr, Oskar Schultze and Braus, all eminent investigators. Kölliker spent fifty-eight years of his long life in the small University of Würzburg, declining the many offers which came to him from universities in three different countries. The spirit of these laboratories has been so permeating that an almost lasting inspiration is derived from it. In the physics institute, two buildings away from Kölliker's Anatomie, Roentgen discovered the x-ray in 1895, and in the building across Kölliker Strasse, Boveri did much to lay the basis of experimental cytology and Spemann began his classical studies in experimental embryology. A host of eminent workers have passed through these laboratories and have been imbued with the scientific spirit which pervades them. However, other laboratories of the same university have been unable to entice the spirit to dwell within them, and some have actually lost the spirit they once possessed. The recent director of the fine new pathological institute would on occasion exhibit the crude old desk at which Virchow first wrote his cellular pathology, but the visitor's reaction was usually one of pity that such a desk should be in so spiritless a place.

No university is so fortunate as to be good in all departments, but to be worthy of the name, a university must have at least one department in which the spirit of research resides.

Returning to our own country, many of us know of laboratories which have this spirit—laboratories where persons work with joy and zest. But they are not all in the largest universities nor in the most elaborate buildings. Some are in small and simple places. Still we ask—what is the spirit? One laboratory in a research institution may have it and another may not.

The spirit of a laboratory may arise from one man or it may come from several. It may or may not radiate from a man of great eminence. It may emanate from a man who is neither great nor eminent. One thing seems certain: the spirit comes from a simple man; not from a pompous or proud person but from a generous and open-minded man willing to hear opposing sides and to stimulate different points of view. In the laboratory there should be no effort to suppress opinions, but an open consideration of all problems worthy of discussion. The laboratory should not be a sanctuary for the worship of authorities or heroes, but a free dwelling for students of nature conscious of and charitable to the faults and virtues of those that surround them.

The spirit dwells in the laboratory where there is a sense of proportion. When one idea is exaggerated at the expense of another, natural harmony may disappear and the spirit vanish. As Professor Pupin once said, every scientist must have a keenly developed sense of proportion. And, he added, they usually do—except when it comes to the proportion between the size of their families and the size of their salaries. The laboratory spirit, like ghosts of the night, is a fleeting and tenuous affair. It never exists where time and routine are important. It disappears with an eight-hour day or a six-day week or a nine-month year. The atmosphere is inspiring only where all time belongs to the spirit of science.

In a laboratory of physiology, teaching and research are an almost inseparable pair. One who teaches and does not investigate the problems of his subject becomes a pedant dispensing knowledge only at second hand. Association with students and younger investigators freshly approaching their problems stimulates the more experienced investigator and keeps him alert to the uninitiated points of view. Scientists who spend their time in purely research institutions and do no teaching have not always gained recognition on the basis of their contributions any earlier in their careers than have some of those who have taught while doing their research. One of our wisest university presidents once said that a man need not be given free time for research; if other duties took all his time he would still find chance to do research if he had the spark to do it.

A laboratory should be a home in both the proprietory and time-forgetting senses of the word. In the laboratory one must be completely at ease and feel that it is there he belongs. It is not a place to go to work, in the drudgery sense of that word. The laboratory is a place for the joy of learning in which one should always remain a schoolboy with nature as the only true teacher.

This laboratory has the great future of physiology before it. To appreciate what the future may hold we need only look back on the recent past to the beginning of the century when deficiency diseases were dark mysteries and vitamins were unknown; when the study of the internally secreting glands was

just beginning; when the constitution of the cells and tissues on the basis of their genetic nature was a blank page, and the mind-body relationship was almost entirely mystical; and when the question of whether vitalism or mechanism was the basis of physiological processes was a subject of serious debate. We need strength and courage to dare dream what the next thirty-seven years may bring and to realize how crude and even false many of the scientific positions of to-day may then seem.

The new laboratory is a new home for physiologists. It has all the future of this science within it. Who can say that the greatest discovery may not happen there; the arrangements which bring forth life itself must some day be found in some laboratory. May all those who work in this laboratory be inspired by the spirit of Theobald Smith, and with a quiet modesty may they whisper their questions to nature, and if she answers, may they have the simplicity to understand.

AGRICULTURAL RESEARCH IN CHINA.[1] II

By H. K. HAYES

CHIEF, DIVISION OF AGRONOMY AND PLANT GENETICS, UNIVERSITY OF MINNESOTA

Entomology: Courses in entomology are taught in each of the agricultural colleges previously listed and courses are given also in the private colleges of Yenching University, the Peiping Union Medical College, the Soochow University, the Chen Tan University and in Fukien Union College. Research work of various sorts is carried on at most of these institutions. Mr. F. C. Woo, head of the department of plant pathology and entomology of the National Agricultural Research Bureau, furnished a list of entomological workers in China. This list consisted of 26 professors, 4 assistant professors, 11 instructors, 17 senior entomologists, 7 assistant entomologists and 12 assistants. This list of 77 workers in entomology, many of whom have had advanced training, gives some idea of the status of entomology in China. It should be appreciated that in entomology and other fields of agricultural research there is a large body of students who have graduated from middle schools, and other schools of a similar nature, and who make admirable assistants but who have not been listed in this survey.

Several special schools have been conducted for the purpose of training research assistants and extension workers. A one-year short course was held by Southeastern University in 1928–29 and 20 students completed the course work. The Bureau of Entomology of Chekiang conducted a similar training school for each of three years from 1931 to 1934 and 87 students completed the short course. In 1936 the National Agricultural Research Bureau conducted a National Training School for Insect Control. Eighty-seven technical workers or agricultural school teachers from 15 provinces were in attendance.

The first application of scientific methods for the control of insects in China, since the formation of the Republic, was in 1919 when private funds were given at the request of Dean Tsou, of Southeastern University, to aid in controlling an outbreak of the cotton looper. A few years later the Kiangsu Provincial Bureau of Entomology was established at Southeastern University, now called Central University.

In 1924 the Chekiang Government established a Bureau of Entomology, which was located at Kashing but moved to Hangchow in 1934. This laboratory has made many important studies of injurious insects, has an extensive insect collection and a good library. The provincial governments of Szechuan, Kiangsi, Kwangtung and Honan have Provincial Departments of Entomology connected with their local departments of agriculture.

The Entomological Department of the National Agricultural Research Bureau consists of six experienced entomologists, one senior chemist and fourteen assistants. Studies of the rice borer and of stored-grain insects are conducted in cooperation with the National Rice and Wheat Improvement Institute. Other research studies are carried on with the migratory locust, forest insects and insecticides. The most important contribution of this department in cooperation with the Cotton Improvement Institute is the invention of cotton-seed-oil emulsion for aphis control. The new insecticide is more satisfactory and the cost is only about one third as great as kerosene oil emulsion.

This brief summary gives some idea of the status of entomology in China and indicates rapid development of this important field in recent years.

Horticulture: Several of the agricultural colleges have departments of horticulture. The more important of these are the Colleges of Agriculture of the Universities of Nanking, Chekiang and Lingnan, the Hopei Provincial Agricultural College and the Northwestern College of Agriculture at Wukung. Horticultural crops in China are of great importance and China is particularly fortunate in the large variety of

[1] Address of the vice-president and chairman of the Section on Agriculture, American Association for the Advancement of Science, Atlantic City, December, 1936.

vegetable crops that are so widely grown. The more extensive experimental work with some farm crops, as with wheat, rice kaoliang and millet, than with most horticultural crops is without doubt due to the necessity of increasing the supply of food of those crops that represent the basic food supply of the nation. As time and funds permit it may be expected in the near future that the work with horticultural crops will be greatly expanded.

Citrus fruit crops have been worked with extensively in Chekiang, Fukien, Kwangsi, Kwangtung, Hopei and Kiangsi. Varietal surveys and storage problems have received the most attention. Varietal surveys with peaches have been made in the provinces of Chekiang, Kansu and Shantung and the better varieties have been learned. The problem of de-astringing persimmons that belong to the astringent group has been worked out.

With vegetable crops extensive breeding studies are under way at the University of Nanking with varieties of radish and cabbage. Studies of watermelon have been made in several provinces with particular reference to varietal differences, cultural methods and the breeding of improved varieties. Cultural studies are being made with orchids at the University of Chekiang, and propagation and classification studies have been made with shrubs and trees at the Lushan Arboretum and Botanical Garden in Kiangsi.

Many of the larger cities in China have well-developed park systems, and the work in these parks along horticultural lines is rather extensive. Studies of varieties of fruits, such as watermelons, peaches and pears, and of ornamentals, like chrysanthemums, peonies and roses, are of great value in varietal surveys and in education of the public.

Forestry: According to D. Y. Lin,[7] who discussed forestry in the Chinese Yearbook, regular college courses in forestry are given at Nanking University Peiping Agricultural College and the Agricultural College of Central University. Special courses in forestry are given also at several agricultural colleges in the provinces of Chekiang, Honan, Anhwei, Kwangsi, Szechuan, Hopei and Kwangtung. The Northwestern College of Agriculture and Forestry at Wukung has been organized recently.

Under various provincial bureaus, such as the bureau of reconstruction, the bureau of industries or the office of forestry, extensive work is under way in most of the provinces. The budget for this work is over one million dollars annually, the total number of district forest stations is 80 and the number of technical trained men at these stations is 118.

The Central Afforestation Bureau organized in 1929 by the Central Government has set up a model forestry area around Nanking and over fourteen million seedlings have been set out.

The National Agricultural Research Bureau has a department of forestry with 6 research workers. Experiments are conducted at the bureau in cooperation with the Sun Yatsen Memorial Park, where experiments are being made on reforestation. Studies of forest plantings are being made with the College of Agriculture of Honan University and the Chan Shan Provincial Forest Station of Chekiang.

Animal Husbandry and Veterinary Science: In an article on animal husbandry in the Chinese Yearbook for 1935–36 Mr. Vougi Tsai[8] makes the statement that "China ranks second in the world animal industry." An estimate of number of units of live stock in 1935 was made in "Crop Reports" by the National Agricultural Research Bureau.[9] This includes the provinces of Chahar, Suiyuan, Ninghsia and Tsinghai and 17 provinces in China proper but lacks data for the province of Kwangsi. These data then include the numbers of units of live stock for 1935 for 21 provinces (see Table 4).

TABLE 4
UNITS OF DIFFERENT KINDS OF LIVE STOCK
(UNIT, 1,000 HEADS)

Productive animals		Labor animals	
Kinds	No. units	Kinds	No. units
Sheep and goats	42,890	Water buffaloes	11,603
Hogs	62,639	Oxen	22,647
Chickens	246,088	Horses	4,080
Ducks	56,724	Mules	4,666
Geese	10,538	Donkeys	10,547

It is apparent that animal industry is of great importance in China. It should be remembered, except for a few provinces, that crops are raised primarily for human consumption and that by-products are used as fodder. In general there is little use of hay and pasture crops and except in the region of larger cities no dairy industry. In Northwestern China there is a large area of grazing land, and alfalfa is grown rather extensively in certain sections. Wool production is the principal animal industry in this region.

Several of the agricultural colleges have departments of animal husbandry. These are found at Central University, Nanking; Sun Yatsen University, Canton; Honan Agricultural College, Honan University; the Agricultural College of Peiping University; Northwestern College of Agriculture, Wukung; the College of Agriculture of National Szechuan University and the Institute of Kansu, with a Junior College of Agriculture and courses both in animal husbandry and veterinary medicine.

Veterinary schools comprise: (1) the Army Vet-

[7] D. Y. Lin, "The Chinese Year Book," pp. 769–785, 1935–36.

[8] Vougi Tsai, "The Chinese Year Book," pp. 786–805, 1935–36.

[9] Nat. Agr. Res. Bur. China, Crop Reports. Vol. IV, No. 4: 115–118. 1936.

erinary School, under the Ministry of War, with over 30 years' history. Seventeen classes consisting of approximately 500 students have graduated from this school. (2) The Technical School of Veterinary Science at Shanghai, organized in 1932, which gives two years' college training to middle school graduates. The first two graduating classes consisted of about 60 men, most of whom obtained positions immediately. (3) Central University, giving a four-year course, from which approximately 20 men have graduated.

In animal husbandry improvement projects with swine are carried at Central University and at Sun Yatsen University in Canton. The studies at Central University comprise a multiplication of several foreign breeds for extension work, including Large Yorkshire, Berkshire, Hampshire and Poland China and studies on the growth rate of Chinese breeds of swine, while grading up of Chinese breeds is being studied at Central University and at Sun Yatsen University. Breed characteristics of the Peking duck and fattening projects are under way at Central University as well as studies of grading up of Chinese cows for improvement of dairy characteristics by the use of Jersey sires. The milking quality of the Chinese water buffalo has been studied for years at Lingnan University, Canton. With liberal feeding some animals give 4,000 pounds of milk per year with a fat content of from 10 to 15 per cent.

At provincial stations in several provinces there are improvement projects with live stock. The Szechuan Bureau of Animal Industry is carrying on studies with swine and sheep breeding, and the Chekiang Provincial Station recently has started a project on swine breeding. The Kiangsi Provincial Bureau has a department of animal husbandry and is making studies on swine grading, poultry improvement and with the Peking duck. The Kwangtung Provincial Bureau of Agriculture is studying swine improvement. Under the Ministry of Industry there is a Northwestern Breeding Station working chiefly on sheep, while the Ministry of War has an extensive horse-breeding station, where studies are made also of disease control.

Much of the live stock of China has become adapted to particular conditions of environment through long years of selection and while inferior to foreign breeds in many respects it is generally believed that the native breeds are hardier and better adapted to local conditions than introduced breeds. For these reasons it appears feasible to grade up native breeds through crosses with foreign breeds rather than introduce foreign breeds for direct use.

The department of animal husbandry and veterinary science of the National Agricultural Research Bureau under the Ministry of Industry has a force of two senior veterinarians, one bacteriologist and five veterinary assistants at the Central Station in Nanking and two field stations, one in Kiangsu and the other in Chekiang Province, with one senior veterinarian and five assistants. Ten different kinds of serum, vaccine and diagnostic reagents are being produced. Anti-hog-cholera serum is being produced on a large scale to supply field stations for hog cholera control. Special attention is being given to the development of serums and vaccines and special research studies are being made of important diseases of animals.

There is a serum laboratory at Tsingtao in Shantung Province under the Ministry of Industry and a Northwestern Epidemic Prevention Bureau for the control of human and animal diseases. Several provinces have provincial bureaus where studies are carried on for the control of diseases. The Kwangsi Provincial Bureau of Animal Husbandry is producing rinderpest serum and vaccine on a large scale and has as its aim the eradication of rinderpest in the province. The Agricultural Institute at Nanchang in Kiangsi Province is developing a comprehensive plan for the control of animal diseases and is manufacturing serums for provincial use. The Szechuan Provincial Bureau of Animal Industry and the Kwangtung Provincial Bureau of Agriculture have project work on the control of animal diseases.

A partial picture of the status of animal husbandry and veterinary medicine in China can be gained by summarizing the number of men in teaching and research with a college degree. Disregarding the Army Veterinary School at Shanghai and making estimates for those institutions where the number of assistants was not known would give 8 professors and 16 assistants in animal husbandry in colleges giving courses and carrying on research in animal husbandry and 4 project leaders and 14 assistants in provincial departments carrying on research in animal husbandry.

In veterinary medicine there are approximately 5 professors and 8 assistants in college departments, 4 project leaders and 14 assistants in provincial departments and 7 project leaders and 14 assistants in departments under the control of the National Government. To this list must be added a large number of assistants who are graduates of middle schools and who have had special training in short courses.

This seems to be a relatively small number of research workers in animal industry in proportion to the value of the industry in China.

Sericulture: Some time ago raw silk was of first importance in China's export trade. While the rapid decline in the value of raw silk exports in recent years may be due largely to world-wide depression, the value of the industry in China has led to extensive and intensive studies for the improvement of the silk industry.

The Department of Sericulture of the National Agricultural Research Bureau, Nanking, with 6 project leaders, is centering its attention on the improvement of silkworms by breeding, using methods that rather closely parallel those which have been used successfully in the United States with corn. Diseases and parasites and their control are being studied also as well as varietal trials of the mulberry tree.

There are departments of sericulture at the National Central University, the University of Nanking, National Chekiang University, National Sun Yatsen University, Lingnan University and Liao Chung Kai Agricultural and Industrial School, Canton. At these institutions there are 16 project leaders working with silkworms. The breeding of silkworms is being studied at all 6 schools, the genetics of silkworms at 2 schools, diseases at 3 schools and varietal trials with the mulberry tree at 2 institutions.

The Provinces of Kiangsu, Chekiang and Szechuan have sericultural experimental stations, with 5 project leaders. All three stations are studying silkworm breeding, while the stations in Kiangsu and Chekiang are making varietal trials of the mulberry tree. Diseases of silkworms are being studied in Szechuan Province. Several of the provincial stations are distributing silkworm eggs to the growers. Thus in the provinces of Kiangsu and Chekiang more than three million sheets of improved eggs were used in 1934.

In addition to the above institutions and experiment stations the International Committee for the Improvement of Sericulture is carrying on a silkworm breeding project and the Bureau of Sericulture in Canton is making studies on the uses of silk, the control of diseases and the breeding of improved varieties.

The Sericulture Improvement Committee of the National Economic Council, organized in 1934, has extensive studies under way for the improvement of all branches of the silk industry.

The provinces of Szechuan, Chekiang, Anhwei, Hupeh, Shantung and Kiangsu have extension bureaus for sericulture. The most important phase of their work is the distribution of improved disease-free eggs, a total of over one hundred thousand cards of eggs having been distributed. Other phases of work in some provinces include the distribution of improved mulberry trees and the organization of cooperatives for the sale of farmers' products.

Other research fields: In addition to the lines of work mentioned already, probably the most important other phase of agricultural research in China is in agricultural economics. The studies of Dr. Buck at the University of Nanking are well known. This work is being continued on a large scale, is well supported and is making available to workers in other countries an accurate picture of farming conditions in China. It is helping, also, to make known some of the important farm problems and is aiding in their solution. The Crop Reporting Service of the National Agricultural Research Bureau, inaugurated in 1933, is of great value in making available statistics of crop production.

According to statistics made available by W. S. Tong, of the Department of Agricultural Economics of the National Agricultural Research Bureau, there are four colleges or universities that have special departments of agricultural economics, and courses in agricultural economics are given in 18 other colleges or universities. To date 121 graduates have majored in agricultural economics, including students from the University of Nanking, National Peiping University and National Chekiang University. In addition to the University of Nanking and the Research Bureau, already mentioned, twelve other institutions are conducting research on agricultural economics.

Research along agricultural engineering lines is being developed at several institutions, although work in this field has not been undertaken to any great extent.

Conclusion

The rapid expansion of agricultural research in China in recent years is one indication of the widespread interest among Chinese leaders in improving the living conditions of the people. The present tendency is to work primarily on problems of an immediate practical importance. With the basic farm crops the immediate end in view is to make China self-sufficient. There is, however, in China a growing appreciation of the value of agricultural research as one means of helping to develop efficiency in agriculture.

OBITUARY

JAMES BERTRAM OVERTON

News of the death, on March 18, of Professor Overton came with a shock to a wide circle of close friends, and particularly to the many who have worked with him as students.

James Bertram Overton was born at Richmond, Michigan, on October 23, 1869. His graduation from the University of Michigan in 1894 was followed by a year of high-school teaching at Black River Falls, Wisconsin, and this by three years as senior master in mathematics at St. John's Military Academy, Delafield. In 1898 he began graduate work at the University of Chicago, where he received the degree of Ph.D. in 1901.

For the following two years he served as professor of biology at Illinois College, Jacksonville, which institution later (in 1930) gave him the honorary degree of Sc.D. The year 1903–4 was spent in Strasburger's laboratory at Bonn, under appointment by the Carnegie Institution of Washington as research assistant. In 1904 he came to the University of Wisconsin as instructor in botany. Here he remained, being successively assistant professor of botany (1907), associate professor of plant physiology (1912) and professor of plant physiology (1915).

On December 26, 1901, he was married to Mary E. Cochran, of Ashland, who with one son and two daughters survives.

Overton's work with *Thalictrum purpurascens* was one of the very early studies of parthenogenesis in plants. In this species he first demonstrated that parthenogenesis occurs, and then determined the details of the cytological history which supplies an explanation of the phenomenon. Following this came a series of studies of meiosis, spore-formaton and nuclear organization. Gradually his attention was turned to the experimental phases of physiology, in which his interest had been aroused while working with Barnes and Loeb at Chicago. In this field falls his successful induction of parthenogenetic development under controlled conditions in *Fucus,* a piece of work which recalls his previous study of *Thalictrum.* Most extensive of his physiological investigations were those dealing with the course of the sap flow and with its determining and regulating factors. Part of this work was done at the Tucson and Carmel laboratories of the Carnegie Institution of Washington, where, as research associate, he spent parts of each year from 1925 to 1929. The outcome of these years was a series of studies, published in conjunction with Dr. D. T. MacDougal and Dr. G. M. Smith. At this time also Overton began a study of the structure and history of the long-lived cells which had been found by MacDougal to occur in the stems of certain cacti.

Reference has been made to Dr. Overton's wide circle of friends and acquaintances. His unusually extensive acquaintance was an outcome of his deep interest in human problems and of the capacity for friendship which was one of his notable traits. Somewhat the same type of interest was manifested by his activities in connection with the scientific and other organizations of which he was a member. A fitting recognition of his services in this direction was the award in 1933 by the American Society of Plant Physiologists of its Charles Reid Barnes life membership. He was a regular attendant at scientific meetings until the precarious state of his health in more recent years had made travel, especially in the winter, dangerous and often impossible. Despite frequent illnesses, however, he retained so much of his old-time vigor, and was so active in the interims of comparatively good health, that there was no premonition in any mind of the end that finally came so suddenly.

CHARLES E. ALLEN

SCIENTIFIC EVENTS

THE STANDARDIZATION BUILDING FOR THE BUREAU OF AGRICULTURAL ECONOMICS

A NEW six-story building has been made available for the Bureau of Agricultural Economics to house many of the research activities centering about the standardization of farm products. It will be devoted particularly to standardization and research in cotton, wool, hay, seeds, beans, peas and soybeans. It contains more than seventy-five offices and laboratories equipped for intensive study of the properties and qualities of these products. In addition, it provides warehouse space for more than 1,000 bales of cotton, 600 bales of hay and large quantities of wool, which will be stored under conditions in which fire hazards have been reduced to the minimum. Every effort also has been made to provide for the fullest possible protection of fiber standards employed internationally in world trade of cotton, research records and technical equipment. Special emphasis has been given to provide the best possible natural lighting for grading and classification work and for intensive research related to fiber properties, including color.

On the top of the building is a group of classing rooms for cotton and wool with slanted skylights facing the north. These rooms were designed to be shadowless. They provide lighting conditions which have been found essential in judging color, diameter and other factors in grading fibers. Cotton, wool and hay produced in all areas of the country, and to some extent in foreign countries, will be sampled, classed and graded in connection with the program of evaluating properties and qualities.

Fireproof doors and automatic sprinkler systems in the warehouse section, which may be isolated from the offices and laboratories, are safeguards against the extreme fire hazard. By day and by night all parts of the warehouse will be under constant watch.

Scientific research in the new cotton laboratories will include studies of cotton staple length in relation to staple classification and standardization, the relationship of cotton color to grade classification and stand-

ardization, new uses for cotton, the preparation of cotton for the market, and studies of cotton seed and cotton seed products. The building has a scientifically constructed hay laboratory and warehouse where workers will study hay quality standardization factors. Studies will be made to develop improved methods of determining factors of quality in beans, peas and split peas. Research on wool will include the study of ways to improve methods and practices in the preparation of wool for market and the standardization of wool for length and strength of staple. Experiments will be conducted to perfect a reliable method of determining the shrinkage of wool.

The Standardization Building will be the headquarters of the market news services for cotton, grain, hay, feed, seeds and a number of other farm products. It likewise will be the headquarters for the South-wide cotton quality reporting service involving the issuance of cotton grade and staple reports on the growing crop.

In the new building government standards for the various commodities will be prepared, and the cotton appeal board will function in settling trade disputes over classifications of cotton according to the standards.

PROPOSED WILDLIFE CONSERVATION INSTITUTE AT THE UNIVERSITY OF WISCONSIN

ESTABLISHMENT of a Wildlife Conservation Institute, composed of four divisions, under which the University of Wisconsin would utilize every opportunity to contribute to Wisconsin's wildlife conservation movement, is proposed in the third publication of the state university's Science Inquiry. Members of the commission who prepared the report include: Professors Aldo Leopold, agricultural economics; L. J. Cole, genetics; N. C. Fassett, botany; C. A. Herrick, Chancey Juday and George Wagner, all of zoology.

The institute, through which cooperative relationships would be maintained with the state conservation department, with other state and federal bureaus, with the lay movement, with other educational institutions and especially with other departments of the state university able to contribute to conservation, would be composed of a series of four chairs to cover the wildlife field.

These would be those of game management, already established; fish management, floral conservation and ornithology and mammalogy. Each of the four divisions could be connected with a present department of the university.

The chair of game management, established by the Wisconsin Alumni Research Foundation in 1933, is now connected with the College of Agriculture. The chair of fish management, which would apply to aquatic conservation problems the great accumulation of research on Wisconsin waters collected during the past half-century by the Wisconsin Natural History Survey, would be attached to the department of zoology. The chair of floral conservation, designed to work out techniques for conserving non-commercial plants, would be attached to the department of botany, while the chair of ornithology and mammalogy, which would work out techniques for conserving non-game birds and mammals, would be attached to the department of zoology.

Each of the four chairs which would compose the Wildlife Conservation Institute would teach cultural courses to non-professional students, would do research with the help of graduate students aiming at professional careers, and would build up demonstration areas and other physical equipment for research and teaching.

The Wisconsin Science Inquiry, of which the wildlife conservation publication is the third, was established at the university in 1934. The objective of scientific studies made under the inquiry is to appraise the nature of a certain problem and its significance to the state, to examine the facilities available for its study at the university and to sketch the outlines of a more comprehensive attack upon the problem for the benefit of the state.

GIFT TO BROWN UNIVERSITY OF A CHEMICAL RESEARCH LABORATORY

A GIFT of $500,000 to Brown University to construct a new chemical research laboratory was announced on March 29 by President Henry M. Wriston. The gift is from Jesse H. Metcalf, formerly United States senator from Rhode Island, a member of the Board of Trustees.

The fund will be used to build and endow a laboratory for research in specialized phases of electrochemistry and photochemistry. The new building will more than double the present accommodations and equipment for research. A site for the laboratory will be chosen in the near future. Actual construction will begin as soon as plans can be approved and contracts let. The new laboratory is expected to be ready for occupancy by next spring.

Research in chemistry for the last seventy-five years has been conducted for the most part in the Newport Rogers Laboratory. The new building will contain research equipment for between thirty and forty graduate students and for the research staff, more than twice as many as can be accommodated now. It will have adequate library facilities. It will in future be possible to give undergraduates majoring in chemistry added opportunity to carry on chemical investigations of their own.

Mr. Metcalf's interest in the department has been

largely responsible for the expansion of its facilities in recent years. In 1922 he gave funds for the construction and endowment of the Jesse Metcalf Memorial Laboratory, named in memory of his father. At the same time he endowed a series of graduate fellowships and scholarships. His brother, the late Manton B. Metcalf of the class of 1884, also gave $100,000 for the endowment of the department of chemistry. With these gifts and the new facilities and financial support the department has developed into one of the strongest in the university. The opening of the Jesse Metcalf Memorial Laboratory in 1923 led to the introduction of a specialized undergraduate course of study leading to the degree of bachelor of science in chemistry, and to the expansion of the program of graduate work in the field of chemistry.

In a statement made by Professor Charles A. Kraus, research professor of chemistry, he said that the principal investigations to be carried on will be on problems in photochemistry, on the properties of electrolytes and dielectrics and on problems in organic and physical chemistry.

THE NEW BUILDING OF MELLON INSTITUTE

The new building of Mellon Institute, the gift of Andrew W. and Richard B. Mellon, will be dedicated on May 6. It is outwardly classic in form, but within it contains laboratories and equipment of modern design. These new facilities will eliminate the overcrowded condition of the past and will increase the activities of the institute in both industrial research and research in pure science. The requirements of the institute made necessary a building of about six and one half million cubic feet. It is of limestone and granite.

Because of the massive exterior of the building, which has a rectangular row of sixty-two Ionic columns, it would have been impossible to place sufficient windows in the outside walls to provide adequate light for the numerous laboratories and offices. For this reason it was designed to include four interior courts as the main natural light sources. It is in the form of a hollow square, wider at the front than in the rear and with center and connecting wings in the form of a cross. The outside sections which surround the hollow square are nine stories high. The center wing, intersecting the square from front to rear, is of the same height. The cross wings, which connect the center wing with the east and west outside sections, are four stories high.

The fifth to eighth floors, inclusive, are devoted to laboratories for investigators on the staff of the institute. Each floor has special rooms for the use of all fellows, but most of the space is devoted to laboratories of two types—small laboratories for individual workers opening into the marble corridor, and larger laboratories arranged in suites, each with an office. The laboratories have exceptionally large windows and the courts on which they face are surfaced with glazed ivory terra cotta having high light reflectance.

The interior of the building is said by specialists to have the best arrangement and grouping of research laboratories possible. Back of the columns are abundant facilities intended to be both useful and convenient. There are in fact beauty and utility in all parts of the building and particularly in the library, the social room and the auditorium, which will make possible the holding of important scientific meetings at the institute. Automatic elevators, with massive but light aluminum doors opened and closed by photoelectric cells, connect conveniently all floors.

The same administrative procedure that is the day-by-day practice in the laboratories was applied to the construction and equipment of the new building. Test laboratories, for instance, were installed in a temporary building, and for two years details of equipment and arrangements were studied for possibilities of improvement. As a result, the wiring, piping and other systems were evolved, the wall brackets and removable cabinets designed and other details worked out. Piping is accessible, yet out of the way. Wall brackets are so built that shelves may be placed at will and instantly removed. Cabinets are constructed so that a complete unit may be removed and shifted to another laboratory when desired. Furniture is made without bolts or screws—only a rubber mallet is needed to take apart the laboratory tables or to add to them.

Among other special features are the constant-temperature, constant-humidity rooms, facilities for nutritional studies, a section of laboratories devoted to ceramic furnaces, ample room for the grouping of unit or experimental plants for basic production research in evolving chemical manufacturing processes, an analytical department, machine, instrument and glass-blowing shops and x-ray and spectroscopic facilities, all available for the use of fellows of the institute.

According to Dr. Edward R. Weidlein, director of the institute, more fundamental knowledge is to be sought through the expansion of the staff and facilities in those departments dealing with research in the pure sciences. The institute has maintained a department of research in pure chemistry since 1924 and has made important contributions to that science and to public health. It will now be able to devote attention to major problems in the fields of pure physics and biology. Industrial research for which it is best known will continue to be encouraged fully and will be benefited by the research in the pure sciences. At present sixty-five industrial fellowships are in operation.

SCIENTIFIC NOTES AND NEWS

At the dinner on March 30 of the first International Congress on Fever Therapy, held in New York City, the French government, represented by Count Charles de Ferry de Fontnouvelle, French Consul General of New York, conferred membership in the Legion of Honor on four Americans who have been foremost in fever therapy experiments. They were: Dr. William Bierman, president of the American Congress of Physical Therapy and director of the department of physical therapy at Mount Sinai Hospital; Charles Franklin Kettering, vice-president of General Motors Corporation and director of its research laboratories; Dr. Walter Simpson, one of the pioneer workers in this country in the production of fever, and Dr. Willis Whitney, retired director of the General Electric Company's research laboratories. Dr. Simpson and Dr. Bierman were recognized for their experiments and research in artificial fever; Mr. Kettering and Dr. Whitney for discoveries and inventions that had helped to apply fever therapy in a practical manner.

The Howard Crosby Warren Medal for outstanding research in experimental psychology has been awarded for 1937 to Professor Karl Spencer Lashley, of Harvard University, "for his distinguished work on the physiological basis of learning and on the neural mechanisms involved in vision." The award was made at the annual meeting of the Society of Experimental Psychologists, Inc., held at Smith College, Northampton, Mass., on March 25 and 26. The Warren Medal was established in 1936 through the generosity of Mrs. Warren in memory of her husband.

At the annual general meeting of the Institution of Petroleum Technologists held on March 9, the Redwood Medal was presented to Mr. Harry Ricardo, in recognition of his contributions to the advancement of the science and technology of petroleum.

Nature reports that the Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee Prize for the period 1932–36 to Professor C. G. Darwin, master of Christ's College, Cambridge, formerly Tait professor of natural philosophy in the University of Edinburgh, "for his distinguished contributions in mathematical physics"; and the Makdougall-Brisbane Prize for the period 1934–36 to Dr. E. M. Anderson, formerly of H.M. Geological Survey (Scotland), for his paper "The Dynamics of the Formation of Cone-sheets, Ringdykes, and Caldron-subsidences," published in the society's *Proceedings* within the period of the award.

The Senate of the National University of Ireland has voted to confer on Hugh O. Hencken, director of the Harvard archeological expedition to Ireland, curator of European archeology at the Peabody Museum at Harvard University, the honorary degree of Litt.D.

The degree of doctor of science has been conferred by the University of Oxford on Dr. The. Svedberg, professor of physical chemistry at the University of Upsala.

Dr. Julius Wagner-Jauregg, professor of psychiatry and neurology at Vienna, celebrated his eightieth birthday on March 7.

At a meeting of the Royal College of Physicians, London, on March 22, Lord Dawson of Penn was reelected president.

Officers of the Geological Society of London have been elected as follows: *President,* Professor O. T. Jones; *Vice-presidents,* Professor W. T. Gordon, J. F. N. Green, Professor W. J. Pugh and Professor H. H. Swinnerton; *Secretaries,* Dr. L. Hawkes and Professor W. B. R. King; *Foreign Secretary,* Sir Arthur Smith Woodward; *Treasurer,* F. N. Ashcroft.

Dr. John G. Kirkwood, of Cornell University, who received the 1936 award in pure chemistry given by the American Chemical Society, has been appointed associate professor of chemistry at the University of Chicago. Dr. George W. Wheland, now in England as a Guggenheim fellow, has been made instructor in the department of chemistry.

Dr. E. G. Anderson, of the California Institute of Technology, has returned to Pasadena after spending the past three months at the University of Minnesota as guest professor, teaching advanced courses in plant genetics.

Dr. Paul H. Fall, since 1920 professor of chemistry and head of the department of chemistry at Hiram College, has been appointed associate professor of chemistry at Williams College.

Dr. Wayne Dennis, of the University of Virginia, has been appointed visiting professor of psychology at Clark University for the academic year 1937–38. He will offer work in child psychology and social psychology. Dr. Robert H. Brown has been appointed assistant professor of psychology and philosophy, beginning with the opening of the same year.

Dr. James Archibald Douglas, of Keble College, has been elected to the chair of geology at the University of Oxford.

Professor Samuel Sugden, of Birkbeck College, has been appointed to the university chair of chemistry tenable at University College, London.

Dr. Arthur B. Cleaves, who has been appointed junior geologist on the Pennsylvania Topographic and Geologic Survey, has been elected permanent secretary of the Field Conference of Pennsylvania Geologists, Harrisburg.

The Lucius N. Littauer Foundation has awarded a grant to Dr. Israel S. Kleiner, professor of biochemistry at the New York Medical College, to aid in his studies of the male hormone.

Dr. H. J. Muller, formerly professor of genetics at the University of Texas, who has been working with N. I. Vavilov in Soviet Russia, reached Valencia on his way to Madrid on March 15 to join the Canadian blood transfusion unit. He expects later to resume his work in Moscow.

Dr. Edwin Grant Conklin, emeritus professor of biology at Princeton University, lectured on "Biology and Social Problems" on April 2, 3 and 9 on the Richard B. Westbrook Free Lectureship Foundation of the Wagner Free Institute of Science, Philadelphia.

Dr. Harold C. Urey, professor of chemistry at Columbia University, delivered the lecture at the annual public meeting of the Harvard University Chapter of the Society of Sigma Xi on March 31. His subject was, "The Problem of the Concentration of Isotopes."

Dr. C. N. H. Long, professor of physiological chemistry at Yale University, will deliver the seventh Harvey Society Lecture of the current series at the New York Academy of Medicine on April 15 at 8: 30 P. M. Dr. Long will speak on "The Influence of the Pituitary and Adrenal Glands upon Pancreatic Diabetes."

Dr. Chester M. Alter, of the department of chemistry of Boston University, lectured on March 22, 23 and 24 on "Radioactivity and the Determination of the Age of the Earth" before the faculty and students of science at Colby College, Bowdoin College and Bates College.

Dr. William Healy, director of the Judge Baker Guidance Center, Boston, will deliver the fifth series of the Thomas William Salmon Memorial lectures at the New York Academy of Medicine on April 9, 16 and 23. The titles of the lectures are: "Foundations of the Personality Structure," "The Developing and Emerging Personality" and "Personality in Widening Human Relationships."

Dr. Alexander Silverman, head of the department of chemistry in the University of Pittsburgh, delivered the inaugural Charlotte A. Bragg Memorial lecture in chemistry at Wellesley College on March 19. He spoke on "Glass and the Modern World."

The scientific sessions of the American Heart Association will be held on June 7 and 8, from 9: 30 A. M. to 5: 30 P. M., in the Viking Room, Haddon Hall, Atlantic City, New Jersey. On Monday, June 7, the program of the Section for the Study of the Peripheral Circulation will be given. The general heart program will be presented on Tuesday, June 8.

The second International Conference of History of the Americas will be held in Buenos Aires from July 5 to 10 of this year, under the joint auspices of the Argentine government and the Junta de Historia y Numismática Americana. It will have special sections devoted to the history of each of the countries of this hemisphere, for the discussion of topics such as the conquest and any aspects of their political, cultural, economic, military, naval and diplomatic history and numismatics. Societies, historians, professors and other persons interested in this field are invited to participate in the gathering. The president is Dr. Ricardo Levene, formerly president of the University of La Plata, and the secretary is Dr. Mariano Belgrano, Museo Mitre, San Martín 336, Buenos Aires, Argentina.

The estate of the late Noyes D. Clark, of New York City and Bethany, except for specific bequests of $64,000, has been bequeathed to the Sheffield Scientific School of Yale University to set up a Dwight Noyes Clark and Noyes Dwight Clark scholarship fund, in memory of the donor and his father. The estate is estimated to be worth from $500,000 to $1,000,000.

The California Institute of Technology has awarded contracts for four new buildings to be erected at a cost of more than $1,000,000. These include the second unit of the Kerckhoff biological laboratories; the Crellin laboratory of chemistry; the Seeley W. Mudd geology laboratory and Charles Arms geology laboratory. The new unit for biology is financed from a fund given by the late William G. Kerckhoff, of Los Angeles, and Mrs. Kerckhoff. The unit for chemistry is given by Mr. and Mrs. E. W. Crellin, of Pasadena. The third building is the gift of Mrs. Seeley W. Mudd, of Los Angeles, as a memorial to her late husband. The Charles Arms laboratory is given by Mr. and Mrs. Henry M. Robinson, of Pasadena, in memory of Mrs. Robinson's father, operator of mining properties. Mr. Robinson, a Southland banker, is vice-president of the board of trustees of the institute.

For the support of the Kansas State College, Manhattan, for the biennium beginning on July 1, the State Legislature has appropriated $2,511,000, including $450,000 for a new building to house the departments of chemistry and physics.

Announcement of a Museum Building to be constructed at Mound Park, Moundville, Ala., has been

made by Dr. Walter B. Jones, state geologist in charge of excavations in the Moundville area. Plans for the structure call for a central building 130 feet by 43 feet, surrounded on all sides by terraces. The building itself is to consist of a central exhibition hall 40 feet by 60 feet in size, with a wing on each end of the exhibition hall to house burial pits already excavated. No change will be made in these burial pits, which were excavated and put in their present condition by Dr. Jones and his assistants. Remains of the Mound Culture and Mound Indians are preserved in these burial pits, which have been exposed and laid open to view. Construction of the museum is the joint project of the Civilian Conservation Corps and the National Park Service.

REORGANIZATION of the Biological Board of Canada under the name of "The Fisheries Research Board" is provided in a bill introduced in the House of Commons, Ottawa, by Hon. J. E. Michaud, Minister of Fisheries. Mr. Michaud said that the old name was misleading to the public, as the work of the organization was confined to fisheries, and did not extend to biology generally. Some universities did little or no work on fishery research and they would not be represented on the new board. It will consist of fifteen members appointed by the Minister, two from the Department of Fisheries, two representing the Atlantic Coast and two the Pacific Coast fishing industry, and nine scientific men selected from a list which will include nominations by any Canadian university whose staff includes investigators engaged in research bearing on fishery problems.

THE Association of American Medical Colleges has completed the study of the accomplishment of all freshmen in medical schools during the session 1935–1936. Any arts college or university which would like to have a report on those of their students whose records form a part of this study may obtain it by writing to the secretary of the association, 5 South Wabash Avenue, Chicago, Illinois. This study has been made each year since 1928. The records of students in the second, third and fourth year of the medical course may also be obtained if the names of such students are given. The full four-years report applies only to the class which entered medical school in 1932; the first three years for the entrants of 1933; first and second year for the entrants of 1934; freshmen for 1935.

THE *Journal* of the American Medical Association reports that it is hoped to finish the building of the Paris Eastman Dental Clinic in time to hold the dedication ceremonies on July 4, 1937. The president of the French Republic, M. Lebrun, Ambassador William C. Bullitt and a number of other leading French and American personalities will be invited to take part in the ceremonies. The clinic is designed to provide free dental service for children less than sixteen years of age who are unable to pay. It occupies a large area, and the land surrounding the clinic will be converted into parks and playgrounds. The work of the Paris Eastman Dental Clinic will be based on that carried out at Rochester, N. Y., and it should serve as a center for dentists and dental surgeons to carry on research and postgraduate work. It will also aim to teach children and parents the need and value of regular dental work.

THE transfer of the *Discovery* to the Boy Scouts' Association is reported in the London *Times* to have considerably disorganized the arrangements of the British Antarctic Expedition Committee and has made it impossible for them to carry out their original program. E. W. Walker, commander of the proposed Antarctic expedition, states that a certain proportion of financial support was conditional on acquiring the *Discovery* and will no doubt be withdrawn. It is the intention to readjust the organization and draw up a new program.

DISCUSSION

MIMICRY, AS VIEWED BY PROFESSOR SHULL

THE book on "Evolution," by Professor A. Franklin Shull, is, according to the preface, an "attempt to review the field of evolution as it appears to modern biologists, with the genetic bearings indicated wherever these may reasonably be assumed." It is stated that "general books on evolution have . . . lacked any adequate application of knowledge of genetics to the problems of evolution."

One of these problems is natural selection, and the author discusses it with special reference to the theories of mimicry and other forms of protective coloration. Now the field of genetics is scarcely the standpoint from which to survey problems of the coloration of insects as a whole, for genetics are primarily concerned with the basic changes which result in *production* of a certain appearance, whereas the problem for the mimetist is not "how or why" a habit or pattern is produced, but how or why it *survives*. There is thus from the beginning a discrepancy which is constantly apparent between Professor Shull's point of view and

the phenomena which he discusses. The question whether various types of coloration really are of use is treated from a philosophical point of view rather than from that of a naturalist in the field who sees events happening.

The study of mimicry suffers much because it is so often discussed by critics as an isolated, rather peculiar, rare phenomenon exemplified by a few butterflies and moths and made of too much importance by a band of imaginative enthusiasts. Few critics seem to be aware of the great extent of the phenomenon, and Professor Shull is no exception. Thus, page 181 seems either to expose his unfamiliarity with the subject or to be an unworthy attempt to pour scorn upon it. What is to be thought of the statement that the bulk of instances of mimicry are among the butterflies and moths or of allusions to "the alleged mimicking of the lady beetle by other beetles, of a beetle by a grasshopper, of a wasp by a beetle . . ." and so on? "Most instances of mimicry in butterflies occur in a certain small group of subfamilies." This is most misleading in seeming to suggest affinity as the cause of mimicry—a suggestion which can not be sustained for the phenomena as a whole.

Mimicry is of the same order as the procryptic resemblance of a Membracid to a thorn: an insect escapes being eaten because it reminds the enemy of an object which he is not accustomed to eat, either because it is unpleasant or because it is of no food value. Affinity does not account for the resemblance of a caterpillar to a twig or a bird-dropping, neither does it explain the superficial resemblance of a fly to a wasp.

Mimicry is embraced by the sentence (p. 167), "the animals are presumably seen but are regarded as of no interest by prospective predators," which the professor applies to procryptic species. Carrick[1] showed that a bird taking food to its young did not perceive stick-caterpillars at rest on twigs at the entrance to its nest, but if these were placed where they were obvious they were picked up and given to the young.

The fundamental principle of *relative* edibility is ignored in such a phrase as "unfit to eat" in an argument on page 177, though the author invokes it for his own purpose on page 172. Edibility depends upon the presence together of a number of articles of food having different qualities of taste. Under pressure of starvation men have been known to devour boots; the present writer has seen a wren in a wood in winter extract from dead leaves and devour a large cock-tail beetle, black and stinking, possessed of all the attributes of a defensively colored species. On the other hand, in his experiments with two young monkeys[2] the writer found that the soft-bodied, brightly colored Lycid beetles were placed by them as near to absolute inedibility as could be expected without real starvation. These beetles, wherever they occur, are mimicked by species of other orders; according to Morton Jones[3] a species was found to be equally unattractive to birds.

Referring to ants, Professor Shull enlarges on the danger of mimicking insects so much devoured by predators. But not by *all* predators! The monkeys mentioned certainly objected to ants running near them and pawed them away vigorously. The writer watched, in an African verandah, a wagtail picking up disabled flies which had been hit by a fly-flapper and, lying on the ground, attracted ants. The bird did not want to eat ants and shook vigorously the corpse of a fly, endeavoring to dislodge the ants which clung to it. If mere number were the chief factor in providing prey the bird could have obtained a greater weight of food had it attended to the ants instead of the less numerous fly corpses.

Another point made by Professor Shull is that protective coloration would not deceive insect enemies (p. 169). The force of this argument is weakened by the fact that nowadays no one supposes that it does: mimicry or procrypsis are not generally supposed to protect against predatory insects. It is true that in the days of teleological theology the resemblance of the fly *Volucella* to the bumble-bee in whose nest it breeds was claimed as a provision of Providence, whereby the fly can enter the nest unharmed, but such views are not in accord with the present day.

The subject of warning colors is lightly treated, and finally (p. 212) contemptuously dismissed, but students of living insects in their natural environment will not agree with this. It is difficult to believe that Professor Shull has any acquaintance with the working of this principle; it is a phenomenon of life and not of museum specimens or logical arguments. What meaning can there be in the following occurrence, unless warning colors *are* accepted as such by predators?

The writer experimented on two young monkeys with miscellaneous insects.[4] A large grasshopper, shiny blue-green and red, which freely exposes itself in the open, was put down for a monkey to see. "It at once erected its wings vertically, showing their purplish-red and black colour, but made no attempt to escape." The monkey "looked very hard at it, took hold of one wing, let go, and again looked very hard at it, but made no attempt to eat it." But he immediately devoured a large procryptic grasshopper put down in the same way, and then another. More con-

[1] R. Carrick, *Trans. Royal Ent. Soc. Lond.*, 85: 131–139, pls. 1–3, 1936.

[2] G. D. Hale Carpenter, *Trans. Ent. Soc. Lond.*, 1921: 1–105, 1921.

[3] F. Morton Jones, *Trans. Ent. Soc. Lond.*, 80: 345–386, pls. 18–28, 1932.

[4] *Loc. cit.*

vincing still was his behavior in the bush under close observation, but free to do as he liked. He found a pair of these warningly colored grasshopper *in copula*, freely exposed on short grass, a fact in itself highly suggestive. He "went up to them and pawed the male. Without attempting to get away, the grasshopper merely erected its wings perpendicularly so as to display their purplish and black colors. The monkey took no more notice and ate some grass. Afterwards he ate other insects, including a large *Cyrtacanthacris* grasshopper." The same maneuver was utilized by another member of this species when threatened by a fowl which ran up to it, halted, gazed at it and walked away. The specimen was then killed, and laid on the ground with its purple wings hidden under the covers; fowls were seen to peck at it but obviously found it very tough and, though they pulled it about, ate none of it. Professor Shull comments on the danger of drawing conclusions from experiments on animal behavior (p. 183), but quotes experiments to show that birds may not see colors as we see them, for "some experiments by Hess on domestic fowls indicate that the middle to red portions of the spectrum are more easily seen than the blue and extreme red."

The inner significance of this is, however, not noted by the critic: it is that, broadly speaking, red, orange and yellow are the very colors utilized for warning, while blue and green are rare in comparison.

"Logical Objections" to natural selection take no account of the facts that the possession of stings, poison spines or irritating hairs, emission of acrid juices or foul odors, toughness and powers of resistance, even to chemical injury, are associated with characteristics of the living animal such as instincts leading it freely and fearlessly to expose itself, often herded in masses whereby conspicuousness is increased, together with slow and heavy gait or flight, the latter sometimes accompanied by a loud rattling noise. Why is such an association not found among insects that resemble their surroundings when it is characteristic of those that have warning colors? And why almost entirely among insects of *diurnal* activity if the colors are not meant to be seen; and if they *are* meant to be seen what other explanation than natural selection fits all the facts?

Professor Shull does not seem to have grasped the principle of common warning colors, for he finds it difficult to imagine how a species can derive advantage by changing from one warning color to another (p. 189). If two species, A and B, each have a pattern which has to be learned by enemies, the loss resulting to each species, *and each pattern*, will be a certain percentage, let us say 10 per cent. But if two species combine to show a single pattern, the loss to the pattern remaining as before at 10 per cent., the loss to the two species bearing that pattern will be 10 per cent. *divided between them*, or between as many more as, through the processes of variation, have been able to enter into that pattern.

The fundamental principle of mimicry, that it is the artist and not the anatomist who is deceived, has a bearing on one of the most important attributes of natural selection, the production of a result by different means. Professor Shull treats this very lightly and reduces it to genetics (p. 184). But an argument based on corresponding mutations fails to explain cases such as that of two Longicorn beetles in Australia which resemble a wasp. The latter bears the characteristic Australian aposeme of red-brown and black in transverse bands. One beetle reproduces the effect on its elytra, the other has the elytra so aborted that such a display is impossible: the colors, however, are shown to the same extent as in the other species, but across the exposed dorsal surface of the abdomen, concealed in the first beetle. The effect is the same to the eye at a little distance.

Two especially striking illustrations of the principle are given by Poulton,[5] but lack of space forbids further treatment of it here. The argument based on corresponding mutations can not stand for mimicry as a whole, nor for its analogue, procryptic resemblance. Would Professor Shull apply it to the resemblance of a moth to a bird-dropping? Even for mimicry between butterflies it has been shown to be invalid.[6]

Professor Shull adduces among his "logical objections" the extremely feeble one, "those few instances in which model and mimic do not occupy the same area" (p. 188). Has he any idea at all of the disparity between the great numbers of cases in which the correspondence in distribution is close and the comparatively few cases in which there is little or no correspondence and for which it may be said, there is a possible explanation which demands further knowledge of the movements of migrating predators? Cases which must be ascribed to pure coincidence do exist, and Dixey[7] carefully examined the question. His paper reveals the weakness of the argument based on coincidence. The fact that Handlirsch is quoted in favor of this argument (p. 192) only suggests that that expert morphologist knew no more than Professor Shull of the correlation in distribution which has been worked out for such African species as *Papilio dardanus, Pseudacraea eurytus, Acraea johnstoni*, for the American *Limenitis* or the Euploeas of Fiji.

Finally, space allows no further criticism than to

[5] E. B. Poulton, *Trans. Ent. Soc. Lond.*, 79: 395–398, pls. 14–15, 1931.

[6] E. B. Ford, "Mimicry" (Methuen's Monographs) by Carpenter and Ford. Pp. 106–7, 1933.

[7] F. A. Dixey, *Proc. Ent. Soc. Lond.*, 1913: 60–69, 1914.

point out that, in this book, mimicry is regarded as a mere question of "similar patterns" (pp. 181, 192). On page 193 we find that color may be "purely incidental" and the suggestion is made that spots occur in a certain place "because in that position the physiological gradient decrees the appropriate mutation." The extremely narrow view of mimicry which prompts such argument ignores the fact that mimicry is not merely a question of color and pattern but of shape, instincts and habits.

Moreover, such an argument takes no account of the resemblance of a moth, beetle or caterpillar to a bird-dropping, of a spider to an ant or of a young grasshopper in which resemblance to an ant is produced by the artistic process of painting out by pale pigment a large part of the corpulent abdomen, so that the narrow "waist" of the ant is pictured by a thin strip of the normal dark color, the remainder of the robust body being rendered invisible in its natural surroundings.

The writer concludes with commending to all students and critics of mimicry the slogan, "Mimicry deceives the artist but not the anatomist."

G. D. Hale Carpenter
University Museum, Oxford

A SYSTEM FOR FILING MONOGRAPHS, PAMPHLETS AND REPRINTS

Several systems for filing pamphlets and reprints have been suggested (Stone[1]; Storer[2]; Eikenberry[3]; Morrey[4]; Harper[5]; Miller[6]; Montgomery[7]; Boring[8] and Smith[9]). Each of these systems embodies certain useful and helpful suggestions. The following plan has been used by me for several years and it has been found to be very efficient. Since many of my friends have commented favorably on the system, I am presenting a brief outline of it so that others may adopt it or certain parts of it.

As monographs, pamphlets and reprints are received, they are classified according to their subjects. If more than one subject is included in a single reprint, as is often the case, then an effort is made to select the subject-division which seems to be the best one suited for my collection. As soon as the reprints are classified according to subjects, a white gum label, 1½ by 15/16 inches, is placed on the upper left-hand corner of the front cover of each reprint or, if the reprint does not have a cover, the label is placed on the corresponding position of the front page. The subject-division of the classification, the number of the reprint in that division and the total series number are all written in that order on the label. For example, the 117th reprint on "Blood" was the 869th paper classified, and the 620th paper on "Endocrines" was the 1880th paper classified. The notations on the labels for these two reprints appear as follows:

Blood	Endocrines
#117	#620
No. 869	No. 1880

If a series of two or more reprints are bound under one cover by the publishers, as is sometimes the case for economic reasons, then the label carries as many numbers as there are separate papers bound together. The label is used so that the notations may be easily read, and this is a definite advantage, since many covers are colored. Also the label serves as an identification tag if one loans his reprints to other individuals.

A card catalogue is arranged according to both authors and subjects for all the classified reprints, and regular 3 × 5 cards are used. If there is only one author's name appearing on a reprint, then it is necessary to make two cards. On one of these the author's name appears first, and it is followed by the title and reference in that order. On the other card, the title appears first, and it is followed by the name of the author and the reference. If there are two authors' names appearing on the reprint, then it is necessary to make three cards: one where the subject appears first, and then each author's name appears first on individual cards. If there are two or more author's names, they are arranged so that each one heads the list. The notations on the label on a reprint are typed in the upper right corner of both the author's and the title cards. The author's cards are arranged alphabetically and kept in a filing cabinet. The subject or title cards are filed in the same order as the reprints appear in a division, and in the same order that the divisions appear in the classified systems, and therefore the title cards for a particular division are kept together in the files. This is particularly handy for surveying the various titles in a division, since it is more convenient to remove several hundred cards to one's desk than it is to remove a corresponding number of reprints. Also, this method tends to preserve the reprints, since they are handled only when they are needed.

As soon as the index cards have been prepared, the separate reprints are filed in drawers with their front covers forward and their backs uppermost. This makes it easy to read the notations on the labels.

If a reprint does not fall into one of my divisions,

1 Witmer Stone, Science, 22: 53, 1905.
2 Tracy I. Storer, Science, 44: 735–739, 1916.
3 W. L. Eikenberry, Science, 45: 64–65, 1917.
4 Chas. B. Morrey, Science, 45: 87, 1917.
5 R. M. Harper, Science, 45: 315–318, 1917.
6 M. R. Miller, Science, 46: 263–264, 1917.
7 Priscilla B. Montgomery, Science, 52: 583, 1920.
8 Edwin G. Boring, Science, 58: 329–330, 1923.
9 Erwin F. Smith, Science, 58: 396–397, 1923.

it is placed in the general file, which is indexed according to the author's name or to the name of the first author, in case there are two or more authors. These filing cards also carry the titles and the references and are filed alphabetically according to the author. The author cards are adequate information for one to determine whether he has received a particular reprint. The reprints in the general file are neither given a number nor labeled. However, as soon as several reprints on some subject accumulate in the general files, they are removed and they constitute a new division. The cards in the general files are removed and the new division, number of the reprint in the division and the number in the series are typed in the upper right corner. A title card is made, and if more than one author's name appears on the reprint, cards are made for each of them as described above.

The advantage of having an author's card made for each reprint that is classified is evident for at least two reasons: first, one has all an individual's references filed together and, second, it saves time in determining whether one possesses any of an individual's reprints and if so, which ones. The cross references might not be so essential if a group of individuals should become associated for life and publish all their researches as from one institution, but since a majority of individuals become connected with two or more institutions during their active careers, it is expedient that each author be given an entry for each paper that bears his name.

If a reprint were dated when it arrived, it would often lead to confusion. The chief reason for not doing so is that one often receives reprints from co-authors after one of them has accepted a position elsewhere. If they had published a series of papers, one might receive the last few numbers of the series from one of the authors, and then some months or years later one might receive some of the earlier numbers from the other author. If one had dated the first papers when they arrived, it would be difficult and confusing to explain why the older papers arrived last.

Reprints from several authors that have been bound and sent to me from some individual or institution are not included in either the classified reprint or the general files, but are given space on the shelves with the bound books. However, if reprints of a symposium are bound together, they are filed according to the division they fall into. Such a volume is given as many numbers as it contains individual articles. That is, if a volume of a symposium contains twelve papers, then the numbers on the label would so indicate.

With this system of indexing and filing, it is as easy to locate a reprint, if you know the author or authors, as it is to locate a book on a regular library shelf. At the present time, I have about 4,000 reprints classified and about 1,500 more in the general files. The classified reprints are filed in steel and wooden drawers, while the general reprints are filed in boxes.

EMMETT B. CARMICHAEL
UNIVERSITY OF ALABAMA
SCHOOL OF MEDICINE

STARS IN THE BIOGRAPHICAL DIRECTORY OF AMERICAN MEN OF SCIENCE

IN view of the publication of a sixth edition of the "Biographical Directory of American Men of Science" I feel impelled to make some remarks about the affixing of stars to certain of the names. The selection of such names is made on a basis that is not very clear to me, and I doubt that it is well defined in the mind of the editor himself. The latter uses such designations as "leading scientific men," "most eminent men," "first—among research workers."

Now I must confess that I regard these elections to stardom as a somewhat childish albeit amusing pastime, but I understand that in some institutions the possession or lack of a star is taken very seriously and may even be decisive in questions of appointment and promotion. In view of that fact I would like to urge that the criterion on which selection is made be given a clearer definition. It should be pointed out that a "leading scientific man" is not necessarily synonymous with a "leader in scientific research." A biologist may be renowned as a writer of text-books and yet have a very poor record in the field of original research. He may be indefatigable and able in the administrative activities of scientific societies and still have only the most superficial interest in scientific discovery. But if eminence may rest on any one of such widely different endeavors it is only fair that that fact be definitely understood. Certainly the editor should make it clear that at present these eminent scientists are not necessarily outstanding research workers.

Personally I would much prefer to see the custom of starring abandoned altogether. I seriously question the justification for printing the results of such an election in a volume which is nothing more nor less than a directory.

FRANZ SCHRADER
COLUMBIA UNIVERSITY

THE PERCENTAGE OF IRON IN HEMOGLOBIN

IT is known that the percentage of iron in different mammalian hemoglobins is substantially the same. In attempting to look up this rather fundamental value for use in teaching, we found the value 0.0335 given in Hawk and Bergeim's "Practical Physiological Chemistry" (10th ed., p. 467), in Starling's "Human Physiology" (7th ed., p. 652), in Bodansky's "Introduction to Physiological Chemistry" (3rd ed., p. 234),

and in Robertson's "Principles of Biochemistry" (2nd ed., p. 390). Reference to the original analyses[1] makes it clear that the above value has an extra zero inserted after the decimal point and that the correct value is about 0.34. The decimal point is correctly placed in the values given in Harrow and Sherwin's "Textbook of Biochemistry" (p. 492), Mathews' "Principles of Biochemistry" (p. 351), Mattice's "Chemical Procedures for Clinical Laboratories" (p. 138), Macleod's "Physiology in Modern Medicine" (7th ed., p. 86), and McClendon and Pettibone's "Physiological Chemistry" (6th ed., p. 143).

BURNHAM S. WALKER
WILLIAM C. BOYD
BOSTON UNIVERSITY
SCHOOL OF MEDICINE

[1] O. Zinoffsky, *Zeitschr. f. physiol. Chem.*, 10: 16, 1886; A. Jaquet, *ibid.*, 14: 289, 1890; G. Hüfner, *Arch. f. Physiol.*, 180, 1894.

REPORTS

RESEARCH IN THE FIELDS OF GEOLOGY, CHEMISTRY AND PHYSICS

IN the spring of 1936 two steps were taken by the National Research Council to ascertain what researches were regarded as especially important and timely in the fields of geology and geography and in the borderlands between geology and chemistry and physics. The first step was to send a letter of inquiry from Dr. E. S. Bastin, chairman of the Division of Geology and Geography, to about 300 prominent geologists and geographers. Those replies that related largely to the recognized confines of geology and geography have been edited and issued in mimeographed form by the National Research Council.

The second step consisted in the establishment of an interdivisional committee, comprising geologists, physicists and chemists, to consider the borderland problems between these sciences. This committee was under the chairmanship of Dr. Thomas S. Lovering. Its purpose was not only to review and appraise the borderland problems but also to suggest modes of attack and the possibility of applying special techniques familiar to physicists or chemists that might prove useful in the solution of certain geologic problems. Much of the work of this committee has been accomplished, and the list of the research problems that it has considered will be published at an early date.

It seems highly desirable when problems requiring a new and difficult technique are started for the investigator to have available information as to where the work in which he is interested can best be carried on and where he may consult with men who have had experience with some of his special problems. It thus seems desirable that the final report include the names of those organizations that have special facilities for or experience with certain types of research problems whose solution requires equipment not commonly available. The committee realizes that it is unable to prepare an adequate list without the full cooperation of the many scientists working in the borderland fields. It is our earnest desire that all individuals, especially chairmen of departments of geology and mineralogy, who know of such special facilities for research of the type listed below, will make them known to some member of the Committee on Borderland Fields of Research before May 15. In the final report, which will be issued as a bulletin of the National Research Council, this committee will publish a list of the problems that have come to its attention and briefly consider the special types of techniques or equipment that can be applied to them, together with a list of those organizations having special facilities or experience with the individual problems.

The committee will confine its activity to the preparation of this report and does not contemplate participation in plans for financing any of the researches suggested. It is hoped that the final report will stimulate research in the borderland fields by some chemists and physicists as well as by geologists. It must be realized by geologists, however, that the brunt of the work has to be borne by them and that the chief contribution which they should expect from physics and chemistry is one of methods or techniques.

The types of research in borderland fields of physics, chemistry and geology, requiring special facilities are listed below:

(1) *Phase equilibria study:*
- Equilibria in anhydrous melts at high temperatures.
- Equilibria in systems containing volatiles at moderately high temperatures and pressures.
- Equilibria in saline solutions at room temperatures.
- Equilibria of sulfides in contact with volatiles such as water and chlorine over a range of temperatures and pressures.
- The alteration of rocks and minerals by hydrothermal solutions over a range of temperatures and pressures.

(2) *Analyses:*
- A control laboratory for the identification and analysis of minerals by x-ray and spectroscopic methods is greatly needed. The services of the laboratory should be available to all and at a minimum cost.

(3) *Colloids:*

The deposition of minerals as colloids and their subsequent crystallization, special attention being given to the sulfides. The studies should be carried on over a range of temperatures and pressures.

The effect of coagulation on size distribution of clay particles.

(4) *The physical chemistry of replacement at moderately high temperatures and pressures:*

Replacement in the geologic sense means the dissolving of one mineral or a group of minerals and the immediate deposition of another mineral or group in the place thus vacated, with no intervening formation of open spaces. An explanation of the physical chemistry of the large-scale replacement of essentially solid rock makes experimental work in the artificial production of replacements under closely controlled conditions of temperature and pressure highly desirable.

(5) *Radioactivity:*

The determination of the radioactive content of rock masses.

The determination of the helium content of rocks.

(6) *Differential pressures:*

The study of the physical and chemical conditions of formation of the "stress minerals," their stability fields and their orientation during crystallization. This research will involve investigation at temperatures ranging up to four hundred degrees Centigrade under differential pressures of many hundreds of atmospheres.

(7) *Determination of physical constants of geologic material:*

Determination of density, viscosity, porosity and the thermal and elastic constants of rocks and minerals in the laboratory.

The determination of as many physical properties as possible of rocks *in situ*, to be correlated with the constants determined by laboratory work on material typical of that studied in the field.

The change in physical constants with changes in temperature and pressure.

(8) *Rock deformation:*

Experimentation with scaled models that are dimensionally correct and the application of photoelastic techniques to the study of changes induced by stress.

(9) *Hydrodynamics:*

The principles of stream and wind action as ascertained by means of hydraulic laboratories and wind tunnels.

Investigation of the terminal settling velocities of masses ranging from small to large size.

The laws governing the orientation of unequidimensional particles under conditions of viscous, turbulent and plastic flow.

Rock permeability under special conditions, such as incomplete saturation, high pressure and high temperature.

(10) *Geophysics:*

Gravity instruments to determine gravity or gradient of gravity on land or on sea.

Seismic equipment for the investigation of general geologic problems, such as the extent of thrust faults and their change of attitude with depth, and the position and configuration of the floors of batholiths, and the structure of the continental shelfs and ocean bottom.

Tiltmeters to determine the body tides of the earth.

Magnetic equipment for investigation of geologic field problems or for investigation of magnetic properties of rocks and minerals.

Committee on Borderland Problems of Geology, Chemistry and Physics.

CHEMISTRY

G. E. F. LUNDELL

H. R. MOODY, *ex-officio* (*chairman*, division of chemistry and chemical technology)

GEORGE W. MOREY

HOBART H. WILLARD

GEOLOGY

E. S. BASTIN, *ex-officio* (*chairman*, division of geology and geography)

W. H. BUCHER

R. A. DALY

C. N. FENNER

BENO GUTENBERG

M. KING HUBBERT

T. S. LOVERING, *chairman*

W. W. RUBEY

PHYSICISTS

HENRY A. BARTON, *ex-officio* (vice-chairman, division of physical sciences)

FRANCIS BIRCH

I. S. BOWEN

C. C. MURDOCK

SPECIAL ARTICLES

MAGNETIC ANOMALIES NEAR WILMINGTON, N. C.

A RECENT paper by one of us presented the results of a reconnaissance survey of the magnetic anomalies of a portion of the North and South Carolina Coastal Plain.[1] Since the publication of this paper the survey

[1] Gerald R. MacCarthy, *Jour. of Geol.*, 44: pp. 396–406, 1936.

has been extended to include the region immediately east, north and northwest of Wilmington, N. C. As the investigation has halted temporarily, it seems advisable to present a brief report on our most recent work.

An Askania vertical field balance, Schmidt type, was used throughout the investigations. Observations, usually at half-mile intervals, were made along all the main and many of the minor highways. In towns observations were spaced as closely as possible; in localities where strong magnetic anomalies were detected they were taken at intervals of one-tenth mile. Although the swampy and often almost impenetrable nature of the intervening country precluded the running of transverses between highways, a fairly close network of highway traverses has been completed.

The magnetically disturbed area near Wilmington is a small portion of a zone of disturbance which is roughly parallel with the trend of the present coastline. The full extent of this zone is not known because our work has been confined to the region between central South Carolina and the area immediately northeast of Wilmington. The trend of this zone is roughly parallel with not only the coastline, but with the general regional trend of the Appalachian structures which are exposed farther to the northwest. It has been suggested that the magnetic disturbances are reflections of Appalachian type structures which are buried beneath the sediments of the Coastal Plain.[2]

The accompanying isogamic, or magnetic contour, map is based upon about 550 observations. The trend

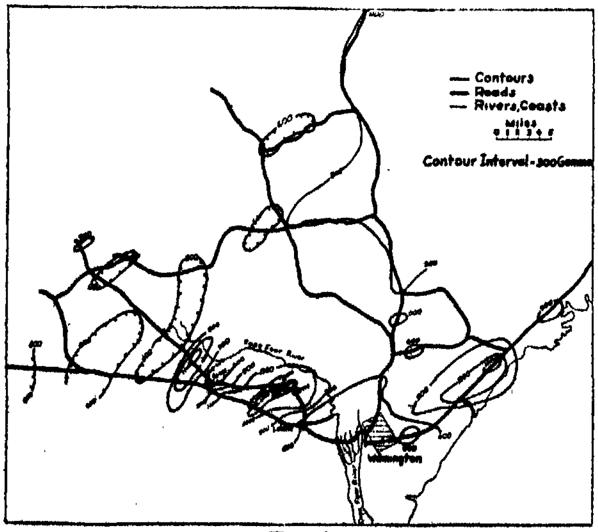

Fig. 1

of the magnetic structures outlined by these isogams is roughly northeast-southwest, coinciding with the trend of the disturbed zone of which they are a part. Most of the magnetic structures are elongated oval highs and lows, the major axes of which are approximately parallel with the general structural trends of the region. The group of distinctly linear and closely spaced highs and lows about twelve miles west of Wilmington is most striking. The maximum anomaly in this particular area is about 1,700 gammas above the regional average. A larger, but less intensely disturbed, area where the coastal highway (U. S. No. 17) follows the crest of a magnetic high for several miles, has been found about ten miles northeast of Wilmington.

The individual highs and lows vary from narrow crests and troughs to broad ovals, with the magnetic gradient steeper along the shorter than along the longer axis, and also steeper toward the northwest than toward the southeast. These facts suggest that the geologic structures responsible for the anomalies dip toward the southeast.

Unfortunately, the country just north and west of Wilmington, through which the axis of the "Wilmington Anticline"[3] should pass, is largely an almost impenetrable swamp. Evidence for or against the existence of this uplift might be expected in this area, but because of the nature of the country, observations have not been made there.

The region here discussed lies within that in which the "Carolina Bays"[4, 5, 6] are found, rendering problems of interpretation somewhat complicated. However, all the non-linear or "point" highs so far discovered in connection with these bays are elongated in a northwest-southeast or a north-south direction, whereas all the highs shown on the accompanying map have a northeast-southwest elongation. The remains of a large iron meteorite might produce a marked magnetic high, but magnetic lows—such as the one that crosses the Acme-Leland highway about five miles northwest of the town of Acme—can not have such an origin. Our present interpretation of the anomalies shown on the map is that they are the reflection of structure and perhaps of topography in the pre-Cretaceous rocks which are buried beneath the sediments of the Coastline Plain. The larger anomalies, such as the one northwest of Acme, are much greater than those usually found in regions of unconsolidated sediments and could be produced only by the presence of large masses of iron-rich material.

The anomalies of this region are not only of scientific, but of practical interest. Noticeable compass

[2] *Ibid.*, p. 405.

[3] The phrase "Wilmington Anticline" as here used refers to an anticlinal structure that has been suggested by L. W. Stevenson. See his paper in *Jour. Wash. Acad. Sci.*, 16: 260–480, 1926.

[4] F. A. Melton and W. Schriever, *Jour. of Geol.*, 41: pp. 52–56, 1933.

[5] W. F. Prouty, *Jour. of Geol.*, 43: pp. 200–207, 1935.

[6] G. R. MacCarthy, *Proc. Geol. Soc. Amer.*, for 1935, pp. 90–91, 1936.

deflections have been observed in this area and, judging by the observed effects associated with equally intense anomalies elsewhere, local interference with radio reception might be expected.

Financial assistance for the field work was received through a grant-in-aid from the American Association for the Advancement of Science.

GERALD R. MACCARTHY
H. W. STRALEY, III

DEPARTMENT OF GEOLOGY,
UNIVERSITY OF NORTH CAROLINA

EFFECT OF CERTAIN ENZYMES AND AMINO-ACIDS ON CROWN GALL TISSUES

THE relation of the crown gall of plants (caused by *Phytomonas tumefaciens*) to malignant tumors of animals is deservedly occupying the minds of pathologists. The status of this subject is excellently presented in a recent paper by Riker and Berge.[1] It is apparent that while the main trend of experimental work is toward determining the stimulatory factors in both crown gall and cancers, comparatively little has been done on the therapy of crown gall with the idea of the ultimate application of the results to cancers of animals. Crown gall and different types of sarcomas have been successfully treated by different forms of radiant energy.[2, 3, 4, 5] There seems to be a certain degree of similarity in response of plant and animal cancerous tissues to different types of physical treatment.

The author working with the crown gall on geranium (*Pelargonium zonale*) observed destruction of galls following injection of a mixture of *Erwinia carotovora* (the cause of a soft rot in carrots and other fleshy roots) strains into galls one month old. Gall tissue usually was completely broken down in from four days to a week, depending on the size of gall and environmental conditions. Galls on young tomato (*Lycopersicon esculentum*) and sunflower (*Helianthus annus*) plants were treated similarly and responded in very much the same way. After the destruction of gall tissue on geranium plants there was no new gall observed to appear after one year. Plants were always maintained in a good growing condition. Geranium plants inoculated with *E. carotovora* were never affected by the organism.

This interesting phenomenon led to the supposition that enzymes or other specific compounds might be involved in the elimination of over-growth. With this thought in mind, the author tested diastase, papain, pepsin, cysteine hydrochloride, leucine, iso-leucine, tyrosine and tryptophane.[6] Cysteine hydrochloride was applied in view of the fact that this material was successfully employed in curing Jensen's sarcoma of white rats.[7] All preparations tested were used in the form of 0.1 per cent. water solution or as crystals. Galls employed for treatment were from one to two months old and ranged in size from 3 to 5 cms in diameter and were induced on geranium and sunflower by a rose strain of *P. tumefaciens*. Injection of materials was made by hypodermic syringe in the case of the water solutions. Dry powder (a few crystals in each case) was introduced into a very small incision made in the center of the gall. Sometimes the galls treated with crystals were afterward atomized with sterile distilled water to aid the diffusion of the material. Controls were represented either by injection of sterile distilled water into the galls or by incisions with a sterile scalpel. In all treated cases, except with tryptophane and tyrosine, the galls gradually collapsed, dried and remained on the plant as hard vestiges easily detachable. Pepsin and papain acted very promptly, while diastase and other compounds used mummified the galls of 3 to 4 cms in diameter in from ten days to two weeks. In all these tests there were used from 10 to 20 galls for each treatment, making a total of 180 galls with corresponding controls.

P. A. ARK

UNIVERSITY OF CALIFORNIA, BERKELEY

[1] A. J. Riker and T. O. Berge, *Amer. Jour. Cancer*, 25: 310–357, 1935.

[2] C. Arnaudi and G. Venturelli, *Rivista di Biologia*, 16: 61–80, 1934.

[3] Georges Lakhovsky, "L'origine de la vie," 175 pp. Gauthier-Villard et Cie. Paris, 1925.

[4] I. Levin and M. Levine, *Jour. Cancer Research*, 7: 163–170, 1922.

[5] J. W. Schereschewsky and H. B. Andervont. Publ. Health Report 43: 927–945, 1928.

[6] Chemicals used were of the following brands: Papain-Merck. Diastase, pepsin, leucine and tyrosine-Pfanstiehl. One lot of pepsin from Parke, Davis and Co. Cysteine hydrochloride, isoleucine and tryptophane—Eastman Kodak Co.

[7] C. L. Connor, J. L. Carr and L. Ginzton, *Proc. Soc. Exp. Biol. and Med.*, 34: 374–376, 1936.

SEX DIFFERENCES IN ANEMIC RATS

IN the issue of SCIENCE for January 29, 1937, appeared a note by Margaret C. Smith and Louise Otis describing certain differences observed between male and female anemic rats in their response to various remedial measures. With those supplements incapable of promoting a maximal rate of recovery, the female rats responded better than the male rats. This was interpreted as a true sex difference, and the authors expressed the belief "that ignorance of this fact may explain some of the discrepancies of the same magnitude in the findings in various laboratories relative to the availability of iron in foodstuffs." Also, in 1932 Miss Helen Mitchell[1] observed an analogous phenome-

[1] *Amer. Jour. Physiol.*, 101: 503, 1932.

non in the rates with which young male and female rats develop anemia on a whole milk diet, from which she concluded "either that the female is endowed with a better prenatal storage of iron or that she uses the iron which is available from endogenous or exogenous sources more efficiently than does the male."

While it is true that male and female rats seem to be used indiscriminately in investigations concerned with nutritional anemia, it is also true that in practically all such work the intake of the basal diet, consisting generally of milk or milk solids, is not under control. It seems to be the general opinion that only the intake of the remedial supplements needs to be controlled, the implication being that a variable intake of the nutrients of milk, which favor the production of anemia, will not modify either the rate with which the anemic condition develops or the rate with which it is corrected. However, in 1930 Nevens and Shaw[2] published a note in this journal in which evidence was submitted that "animals consuming large amounts of milk became anemic more quickly than those limited to small amounts." They used the paired feeding method, involving the feeding of equalized amounts of milk to each of a series of carefully selected *pairs* of rats.

We have fully confirmed the results of Nevens and Shaw and have shown further by the paired feeding method that the response of anemic rats to metallic supplements, in certain concentrations at least, is modified to some extent by the rate of consumption of the basal anemogenic diet, such that the more of this diet is consumed the slower does hemoglobin regeneration proceed.

Since female rats in general grow at a slower rate than male rats and presumably consume less food per day, the question naturally arises whether the sex difference noted by H. S. Mitchell and later by Smith and Otis is a primary difference in iron or copper metabolism, or whether it is merely a sequel of a primary difference in growth impulse.

The experimental results summarized in Table 1 bear directly upon this question. In experiments 1 to 4 inclusive, the basal diet was dried whole milk (Klim). In experiment 5 the basal diet was fresh whole milk. In experiments 1, 2, 3 and 4, one rat in each pair was fed the milk solids *ad libitum,* while its pair mate received two thirds as much as was voluntarily consumed by the first rat. In experiments 1 and 3 the iron and copper supplements were fed in equal daily doses, as indicated, to all rats. In experiments 2 and 4 the supplements were incorporated in the milk solids in the proportions given. The rats in the first four experiments were made anemic by the Elvehjem and Kemmerer method in a prefeeding period. In experiment 5 the rats were taken directly from the stock colony and pair mates were fed equal amounts of whole milk with no supplements. In all experiments rats were paired with reference to initial weight and initial hemoglobin concentration of the blood. In experiments 1 to 4, pair mates were of the same sex, while in experiment 5 each pair consisted of a male and a female, taken, with one exception, from the same litter.

TABLE 1

THE RESULTS OF SOME ANEMIA EXPERIMENTS INVOLVING THE COMPLETE CONTROL OF FOOD AND SUPPLEMENT INTAKE BY PAIRED RATS

Experiment number	Length of experiments weeks	Metallic supplements to basal milk diet	Number of pairs	Average daily intake of dried milk grams	Body weights		Hemoglobin in blood		Average change in hemoglobin level gms/100 cc	Probability of a chance outcome
					Average initial grams	Average final grams	Average initial gms/100 cc	Average final gms/100 cc		
		Constant daily dose of iron and copper								
1	2	.2 mg Fe + .02 mg Cu	6	6.65	96	140	5.90	10.25	+4.35	.0033
	2	" " " " " "	6	4.43	97	105	5.95	12.20	+6.25	
2	4	.5 mg Fe + .05 mg Cu	7	7.45	72	155	4.50	15.20	+10.70	.16
	4	" " " " " "	7	4.97	73	112	4.46	16.00	+11.54	
		Constant daily percentage of iron and copper								
3	2	.004 pct. Fe + .00016 pct. Cu .	7	6.92	94	127	5.53	11.83	+6.30	.015
	2	" " " " " " .	7	4.61	94	100	5.57	12.86	+7.29	
4	2	.008 pct. Fe + 00032 pct. Cu .	8	6.13	68	108	4.23	13.92	+9.70	.0019
	2	" " " " " " .	8	4.09	68	81	4.30	15.14	+10.84	
		Sex comparison on equal food (fresh milk) intake								
5	4 to 6	No supplements—males	6	...	63	115	11.75	6.53	–5.22	.085
	4 to 6	" " —females ...	6	...	63	125	12.20	8.17	–4.03	

[2] SCIENCE, 72: 249, 1930.

The results of experiment 1 show that a daily dosage of .2 mgm of iron and .02 mgm of copper promoted a more rapid regeneration of hemoglobin in those rats receiving the smaller intake of milk solids. In only 2 weeks of feeding a difference in recovery concentration of almost 2 grams of hemoglobin per 100 cc of blood developed. In all six pairs the rat on restricted intake recovered the more rapidly, and the probability[3] that this is a fortuitous result is so small (.0033) that it may be neglected. However, in experiment 2, with a daily supplement of .5 mgm of iron and .05 mgm of copper, the result is indecisive, even after 4 weeks of feeding. In 5 of the 7 pairs the rat on restricted food recovered from its anemic condition more rapidly than its pair mate, but in 2 pairs the reverse was true; the statistical analysis (P = .16) indicates that the outcome may have been a fortuitous one. These two experiments on the effect of a variable intake of milk solids are quite analogous to the experiments of Smith and Otis on the comparison of male and female rats in the sense that significant differences were noted only when the supplements were such as to promote a submaximal rate of recovery. They are also in agreement with the theory previously proposed[4] by one of us concerning unbalanced rations, that "the more of them is consumed the poorer nourished will be the animal with reference to the functions with respect to which the rations are unbalanced." Confirmation of this theory has already[5] been reported with rachitogenic diets: the greater the rate of consumption of such diets, the more rapidly does rickets develop. Vitamin B_1-deficient diets are also the more toxic the more of them is consumed,[6] as are also diets deficient in vitamin C.[7]

Experiments 3 and 4 show in both cases that for the particular iron and copper concentrations incorporated in the milk solids, the rats on restricted intake recovered significantly more rapidly than the rats on one half again as much food. It may be said that the concentration of iron used in this experiment (.008 per cent.) was lower than that consumed by the restricted rats in experiment 2 (.010 per cent.), but higher than that consumed by the unrestricted rats (.0067 per cent.).

Unfortunately we have not performed a curative experiment with pairs of male and female rats receiving equal intakes of milk solids. However, the rate of development of anemia in paired male and female rats receiving equal intakes of fresh milk was studied in experiment 5. In feeding periods lasting from 4 to 6 weeks, no significant differences were obtained, although in 4 of the 6 pairs the female rat was the slower in developing an anemic condition. The probability of a chance outcome, .085, is however too large to disregard. It will be noted also that on equal intakes of food the female rats gained less in body weight (P = .046), and from available information it may be assumed that their gains contained less of protein, more of fat and less of blood.

It may be concluded that the sex difference in the development of nutritional anemia noted by H. S. Mitchell, as well as that in the recovery from nutritional anemia noted by Smith and Otis, may be partially or entirely the result of a greater intake of the anemogenic basal diet by male rats. To that extent it is merely a sequel of the well-established difference in growth impulse between the male and the female sex. In the same manner, the frequently observed difference between male and female rats in the rate of calcium retention and of the calcification of the bones has been traced in this laboratory[8] to the greater demand for, and consumption of, food by the male.

The control of food intake by comparative animals in nutrition experiments according to some scheme adapted to the problem at hand will generally simplify their interpretation and will make possible a demonstration of a fact or a principle where lack of control can at best establish only a variable degree of probability in favor of it.

H. H. MITCHELL
T. S. HAMILTON
UNIVERSITY OF ILLINOIS

CRYSTALLINE CATALASE[1]

WE have prepared crystalline catalase from beef liver. Our method consists essentially in extracting chopped liver wth dilute dioxane, adding more dioxane to the extract to precipitate impurities and then precipitating the enzyme through the addition of still more dioxane. The precipitated enzyme is dissolved in water and crystallizes upon adding ammonium sulfate and cooling. Crystalline catalase has been obtained also from the extracted liver residue by fractionating extracts with ammonium sulfate solution.

Our catalase crystals are slender plates of microscopic size. Presence of the crystals can be observed by rotating the liquid in which they are suspended and

[3] "Student," *Biometrika*, 6: 1, 1908.

[4] H. H. Mitchell, SCIENCE, 80: 558, 1934.

[5] W. E. Watkins and H. H. Mitchell, *Poultry Sci.*, 15: 32, 1936.

[6] G. Amantea and associates, *Atti Accad. Lincei*, 18, 317, 399, 1933; *ibid.*, 20: 134, 1934; *ibid.*, 22: 173, 1936; taken from *Chem. Abst.*, 28, 3764, 1934; 29: 1138, 1935; 30: 6422, 1936. H. G. K. Westenbrink, *Arch. Neerland. physiol.*, 19: 94, 1934; *Ber. ges. Biol.* Abt. B: *Ber. ges. Physiol. u. Pharmakol.*, 79: 585, 1934.

[7] V. Famiani, *Atti accad. Lincei*, 20: 129, 1934; *Chem. Abst.*, 29: 1138, 1935.

[8] B. W. Fairbanks and H. H. Mitchell, *Jour. Nutr.*, 11: 551, 1936.

[1] From the Department of Physiology and Biochemistry, Medical College, Cornell University, Ithaca, New York.

observing the thryxotropy. The crystals stain with methyl violet and are fairly soluble in water. Their dilute solution is yellow. Their concentrated solution is brown and gives an absorption band in the red at 627 m μ and a fainter band in the green at 536 m μ.

Catalase can be recrystallized easily by dissolving the crystals in dilute phosphate buffer of pH 7.3, bringing the pH of the solution to approximately pH 5.4 through the addition of acid potassium phosphate and then adding ammonium sulfate slowly with cooling. The crystals form very rapidly.

One sample of twice recrystallized catalase, after dissolving in phosphate buffer and dialysing until free from ammonium sulfate, was found to possess a "*Kat. f*" of 43,000 and an iron content of approximately 0.10 per cent. Crystalline catalase coagulates upon heating and gives many of the usual protein tests. A strong odor of burnt hair is produced on ashing. The pyridine hemochromogen test is readily obtained.

The properties of our crystalline catalase are in complete agreement with the properties of the catalase preparations of von Euler and Josephson,[2] and Zeile and Hellström.[3]

JAMES B. SUMNER
ALEXANDER L. DOUNCE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF SYNTHETIC RESINS IN THE PREPARATION OF PERMANENT BACTERIAL MOUNTS

THE most common method employed in making permanent preparations of bacterial mounts entails the use of Canada balsam, a naturally occurring resinous substance. It serves as a cementing agent and, when spread upon a glass slide, seals the thin cover slip placed over the mount to protect and preserve the latter for subsequent observation. When permanent mounts are prepared in this manner, several days may be required before the solvent has completely evaporated, leaving a hard cement. In recent years, several synthetic resins have been prepared commercially, solutions of which harden rapidly on exposure to air, giving a hard, clear, colorless layer possessing a refractive index very close to that of glass. Coatings prepared by these resins adhere tenaciously to glass surfaces.

In determining the applicability of these resins, bacterial smears were made on glass slides and stained with dyes commonly used, including crystal violet, carbol fuchsin, methylene blue and the Gram stain. Preliminary investigations indicated that butyl acetate, free of acetic acid, was the most desirable of the organic solvents used. With one resin ("Pontalite"), xylol was substituted for butyl acetate with success. The solutions employed were between 15 and 20 per cent.

Mounts were made in two ways. First, solutions of the synthetic resins were substituted for Canada balsam as the cementing medium. The resin was used in exactly the same manner as the balsam, that is, a drop or two of the solution was placed upon the smear and a glass cover slip placed over it, care being exercised not to include air bubbles. The cover glass was pressed down lightly and the preparation ready for use after ten minutes of air drying.

Secondly, a solution of the resin was applied by tilting the glass slide bearing the mount, lengthwise, at a 45° angle, flooding by means of a dropping pipette and permitting the excess solution to drain off, thus leaving a thin, smooth, glass-like layer of uniform thickness. This may air dry for thirty minutes or more, before being used for observation or, if required at once, drying can be forced by baking the slide at 135° C. for five minutes with no apparent damage to the mount. No cover slip is used, the thin film of resin serving in its stead. When observing mounts prepared in this manner with the aid of the oil immersion objective, xylol can not be used to remove the cedar oil from the slide because of its solvent effect on the resin. The oil can be removed by washing off with ligroin, gasoline or mechanically by merely wiping off with lens paper. Mineral oil, which is often employed as the immersion medium, is much easier to remove from the slides than is cedar oil. If used a great deal, the thin resin layer will eventually become scratched. These scratches can be erased by covering with another film of the resin.

Slides were prepared in February, 1936, in the manner indicated above, using two commercial resins.[1] Each slide was divided into four portions consisting of mounts covered with (a) Canada balsam and a cover slip, (b) the synthetic resin and a cover slip, (c) the synthetic resin alone and (d) an uncovered portion. Over an eleven-month period there has been no noticeable change, such as fading due to the solvent action of the butyl acetate, in any of the covered preparations. Those under the synthetic resin appear as stable as those preserved under Canada balsam.

[2] H. von Euler and K. Josephson, *Liebig's Ann.*, 452: 158, 1927.

[3] K. Zeile and H. Hellström, *Zeit. physiol. Chem.*, 192: 171, 1930.

[1] "Vinylite" (Series A Resin), Carbide and Carbon Chemicals Corporation, New York; "Pontalite," du Pont de Nemours and Company, Wilmington, Del.

Solutions of these resins were also used in making permanent mounts of moulds. The slide was first covered with a uniform layer of the resin in precisely the same manner as described above. The film was then air dried for two to three minutes, at the end of which time it still presented a slightly sticky surface. This surface was then impregnated with the fungus in one of two ways. Either the resin side of the slide was laid gently on the colony, removed and air dried, or a portion of the colony was "fished out" with a platinum loop and these fragments placed on the partially solidified resinous layer, allowing the latter to air dry. Then, employing the methods of the mycologist, the organism was fixed, using any solution which has as a solvent, water, *e.g.*, mercuric chloride—formaldehyde solution. A fixing agent having an organic solvent can not be used because of its effect upon the resin. The preparation was then stained, applying any of the dyes used in aqueous solution, such as safranin, erythrosin or fuchsin.

It is believed that the application of the synthetic resin is superior to the use of Canada balsam from the standpoint of ease of manipulation, simplicity, rapidity and cost.

B. F. SKILES
C. E. GEORGI
UNIVERSITY OF NEBRASKA

A PRACTICAL DEVICE FOR THE RAPID QUANTITATIVE DETERMINATION OF PLANT PIGMENTS

IF the wave-length of the light employed in measuring the absorption of light by a solution is restricted to one of the absorption bands of the solution, the specific transmissive index, symbolized by k, is expressed closely by the equation,

$$k \equiv -\log_{10} T,$$

in which T is the transmittancy.

If, for practical reasons, the wave-lengths of the light employed can not be restricted to a single absorption band, the relation between the light absorbed and the concentration can not be expressed in so simple a manner. The relative transmission can, however, be plotted against the relative concentration; and the concentration of an unknown solution can be determined from the known relative transmission. Evidently, the ideal conditions should be approached as nearly as possible.

In the device we employed, a filter was used, that permitted the passage of only the light having wavelengths ranging from 4,000 to 5,000 Angstrom units. All three plant pigments have absorption bands in this region. The filter was very dense, so that it was necessary to use a powerful light source.

A standard projection lantern having a 500-watt lamp was used. The condenser lenses and the projection lens were set so that the beam of light that fell upon the absorption cell containing the solution was plane parallel. The absorption cell was the kind used in spectrometry. It was in the form of a parallelopipedon and was closed with a glass stopper. Two such cells were mounted in such a manner that the one could quickly be interchanged for the other. The transmitted light was registered by means of a microammeter which recorded the current produced by a photronic cell after being excited by the transmitted light. When the two absorption cells were filled with water, they registered equally 50 arbitrary units when they stood in the same relative position with respect to the optical system and the photo-electric cell.

In practice, one cell was filled with water and the other with the solution to be studied. By means of a shutter device, the light fell upon the absorption cell for only a short time while a test was being made. The light source was kept constant by properly balancing the electrical system. The water reading was made before and after each solution reading. When the solution reading was multiplied by 2 the percentage transmission was obtained when referred to water, since the water was 50.

Standard solutions were prepared for all three plant pigments, using the pure chlorophyll, xanthophyll and carotene. The solutions ranged in intervals of 2.5 per cent. from 0 to 10 per cent., and in 5 per cent. intervals from 10 per cent. to 100 per cent. The 100 per cent. chlorophyll solution represented 5 milligrams per 100 cc of solution, while the 100 per cent. for the other two pigments represented 0.5 milligrams per 100 cc of solution. The values obtained were plotted against the known concentration, and a graph for each pigment was drawn. From the graphs, tables were made that made it possible to read quickly the concentration of any unknown solution from the relative per cent. transmission. Care was taken that all parts of the instrument were constantly in the same position.

The probable error was calculated and was found to be less than 2 per cent.

WILLIAM A. BECK
INSTITUTUM DIVI THOMAE
CINCINNATI, OHIO

BOOKS RECEIVED

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DUNLAP, ORRIN E., JR. *Marconi the Man and His Wireless.* Pp. xxi + 360. 16 plates. Macmillan. $3.50.

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STRONG, EDWARD W. *Procedures and Metaphysics.* Pp. vii + 301. University of California Press. $2.50.

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EMBRYOLOGY AND ITS RELATIONS[1]

By Professor ROSS G. HARRISON

OSBORN ZOOLOGICAL LABORATORY, YALE UNIVERSITY

IT is my impression that what is expected of a retiring chairman is that he inform the section upon the "state of the nation" in his branch of science. Were I to attempt this in a phrase I should say that it was that of the Tower of Babel. On our program papers are listed by the hundred and are presented in various scientific languages, only one or two of which I can speak, and many speakers are talking at once, to the bewilderment of would-be listeners.

In contrast let us go back to the corresponding meeting forty years ago, when the American Society of Zoologists was called the American Morphological Society. Thirty-five papers were presented, four of them by title. A number of them dealt with the centrosome. There were several on biometry, but only one experimental study—that by Davenport on "The Rôle of Water in Growth." Dr. Minot described his newly invented rotary microtome. It is safe to say that had a Rip Van Winkle gone to sleep after that meeting and not awakened until now, he would have scarcely understood any of the papers on this year's program.

One wonders about the origin of all this present commotion, whether it does not go back to the instincts of primitive man—the nomadic hunter and the unskilled tiller of the soil. In his contact with nature he must have been impressed by the great diversity of living creatures as compared with the inorganic, and by their mysterious coming and going. Naturally he was most interested in those animals and plants that afforded food or were otherwise of practical im-

[1] Address of the retiring vice-president and chairman of the Section on Zoological Sciences, American Association for the Advancement of Science, Atlantic City, December 30, 1936.

portance, but many other creatures must have been recognized as indirectly related to his welfare and so have aroused his curiosity. Mystical notions regarding their nature were woven with practical knowledge into a sort of primitive fabric of science and religion not yet altogether disentangled.

Again in the modern development of biology whims and fancies have played a large part; else how can we account for the perverse interest in all the strange things included in the program of our meeting or typified in the appendages of the fabled paleozoic cockroach? A student once said to me that he could conceive of no greater pleasure than that of describing a new species of Staphylinid beetle. My own interest in the development of the fins of fishes was early raised to a pitch; but when I told a lady that I was writing my thesis on this subject, her reply was, "What earthly good are fins? I never eat them." To the layman such aberrations of taste are beyond comprehension. In fact, there is no easier way of holding up learning to public scorn and ridicule than to repeat the titles of Ph.D. theses.

The element of luck has also entered significantly into the development of biology, as in most other lines of human endeavor, not that it does not require intelligence to recognize luck when it comes and perseverance to gather its fruits. I recall a visit to Schermerhorn Hall, about 1910 or at least before the Drosophila visitation. Morgan waved with his hand at rows of bottles on shelves and said: "There's two years' work wasted. I've been breeding those flies for all that time and have got nothing out of it." Much progress has depended upon the fortunate findings of organisms that illustrate this or that principle clearly or such as submit to the most ruthless experimentation. Whole fields of knowledge have depended upon circumstances that are fortuitous as far as the subject itself is concerned. Take, for instance, biparental inheritance. Though it is said to have "Brought death into the World, and all our woe," think what would have been the present state of biology without it! Not to speak of the general drabness of life that would have prevailed, there would have been no genetics. We should have been robbed of the means of studying genes and might even not have suspected their existence. The chromosomes would have remained a perpetual enigma. Embryology would have had to go its way without the help of merogons and hybrids.

Some years ago I had the honor to address you as retiring president of the American Society of Zoologists. My subject was "The Return to Embryology," and my remarks included a certain amount of prophecy which has since come true. I trust, therefore, that you will grant me the indulgence of recalling some of the things then said, especially since they have not found their way into print.

Referring to the fact that all sciences have their ups and downs, it was pointed out that embryology was then (1925) in a period of depression, from which there were signs of emergence. The "organizer" had just been named. Its effects had been discovered some years before, but the importance of Spemann's work was not then so generally recognized. There were a few centers where work in experimental embryology was going on, but the flare-up and the great expectations of the 1890's and the first decade of the present century had subsided. The difficulties of understanding the development of organisms seemed to many insuperable, and no wonder.

The living embryo changes continually; its form, its mechanisms and its functions change; its parts function while changing. These transformations are themselves functions. We have, then, superposed on the ordinary functions of nutrition, respiration, protoplasmic and nervous transmission, action of internal secretions circulating in the internal medium, etc., a whole system of developmental functions, which, as far as we have been able to find out, are totally different from the former. The embryologist has, therefore, a problem of a higher order of complexity—a superproblem—to contend with than has he who directs his attention to the study of the structure or function of the finished organism.

This is usually overlooked. Embryology, from its close relation to comparative anatomy and from the employment of schemata to represent its processes, came to bear the reproach of physiologists that it was a morphological science and on that account dealt with statics and not kinetics. A moment's consideration shows this view to be altogether erroneous. The organism never reaches a state of rest until it has run its course or is securely preserved in a bottle. The physiologist accepts the finished organism as given and endeavors to find out how it works. The embryologist, on the other hand, attempts to show the origin of the mechanisms which the physiologist is content to accept ready made for study. May not the embryologist, then, return the reproach and say that the physiologist is merely looking for something easy to do?[2]

After the first harvests from the virgin field of experimental embryology had been gathered, the workers became impatient and soon landed on the barren ground of theory without the necessary factual equipment for further progress. "There was a time of discouragement. . . . The fertility of the soil seemed to have suddenly run out and tillage no longer worth while. What, more human, then, than the gold rush to genetics and general physiology?"[3] Later came another gold rush to endocrinology, now perhaps at its height.

For the embryologist those days of depression were

[2] Quoted from the 1925 manuscript.
[3] *Ibid.*

peaceful and inviting to meditation. Now in 1936 the predicted gold rush to our own territory is upon us and times are strenuous again. Our program shows two full sessions devoted to embryology, with many demonstrations, a symposium on genetics and development and many papers in other sections having a bearing on embryology. In one sense this is all satisfactory. The liaison between genetics and embryology is now established, but can we say the same of embryology and physiology? Perhaps we are still under the spell of the doctrine that more than one liaison at a time is sin.

There is a growing literature in physiological embryology, but it is still largely physiology of the embryo, as understood by the physiologist. Chemical embryology is also mainly of this kind. Our knowledge of the physical and chemical changes underlying development and differentiation is still deplorably meager.

We may distinguish in the organic world three degrees of transformation, taking place with velocities of three different orders of magnitude, and no doubt related, though precise knowledge of their relations is lacking.

(1) Those concerned with the maintenance functions of the organism—classical physiology.

(2) Those involved in the development or life history of the organism, which are in general of much lower velocity but are closely interwoven with the first group. They appear to be largely but not entirely irreversible.

(3) Those concerned with evolution or transformation of species.

Like the rate of change in the three successive categories of transformation, our knowledge of the processes involved is on a rapidly descending scale. Yet the field covered by the last has dominated biological thought for three quarters of a century! Fifty years ago Carl v. Nägeli, in his oft-cited but seldom read "Abstammungslehre,"[4] excoriated the physiologists for leaving their most difficult and crowning problem to others less competent to solve it, for, as he says, the theory of the origin of organic nature is of purely physiological character. While this phraseology would hardly be considered appropriate to-day in view of our extensive experimental morphology, Nägeli undoubtedly wished to emphasize the essentially functional nature of organic transformations, and the importance of an approach to the problem by experimental methods, which in his time, among biologists, were the possession almost exclusively of physiologists. That zoologists, botanists, anthropologists and paleontologists should have busied themselves with this great problem seemed only natural and highly desirable to Nägeli, but in their speculations they went, in his opinion, far beyond their limitations.

> The theory of evolution touches also philosophy and theology in very sensitive spots and interests the intelligent general public partly for this reason and partly because human vanity has always attached much importance to origin and relationship.
>
> On this account we have seen philosophers, theologians and, in addition, literati of all sorts and conditions take possession of the problem. This too would have been quite in order, if every one had but utilized the established results of scientific investigation for his own field and had rendered to his own circle a clarifying and instructive account of them; and if so many had not considered this field of difficult physiological problems to be a free-for-all arena for senseless argumentation.[5]

Because of early theological opposition, the theory of evolution became for its advocates a sort of religion itself, and not so long ago in this country we witnessed a veritable fundamentalist battle with theological fundamentalism on the one side and evolutionist fundamentalism on the other. The scientific investigation of evolution has suffered severely from this emotional conflict.

While it can scarcely escape any one accustomed to scientific thinking that the processes of evolution can be elucidated only by painstaking experimental work carried on over a long period of years, the short cut to knowledge by the speculative route still holds out great allurement to those whom Huxley called paper philosophers. Even with carefully controlled continuous experimentation, the enormous time involved in evolutionary changes, as compared with the life span of the individual investigator, and the difficulty of devising standards of reference that will hold constant throughout long intervals of time will render the measurement of such change very uncertain. Nevertheless, the development of modern genetics, the experimental study of the origin of mutations and the new mathematical theory of natural selection are hopeful signs of the applicability of exact methods to the study of evolutionary processes.

The difficulties of investigating embryonic development are of a different nature. The velocity of the changes is rapid enough and they may be observed repeatedly, so that experiments are readily carried out, but the scale is minute and a great variety of transformations which are inextricably interwoven are going on at the same time. It is not strange, therefore, that the experimental embryologist has gone ahead wherever a promising lead seemed to open,

[4] C. v. Nägeli, "Mechanisch-physiologische Theorie der Abstammungslehre." München u. Leipzig. R. Oldenbourg, 1884.

[5] *Op. cit.*, p. 4.

without much thought of building up a comprehensive and internally consistent system.

The reference of developmental processes to the cell was the most important step ever taken in embryology. The mutual relationship of the two primary constituents of the cell, nucleus and cytoplasm, both of which are concerned in the development of the organism, has naturally come in for much study. A number of fruitful lines of investigation bearing on this question have been followed, from which it is now generally recognized that, with few possible exceptions, the nucleus in the end controls the character of the combination. It is not to be lost sight of, however, that the nucleus can only work in cooperation with cytoplasm that is not too far removed from it systematically.

From the fact that genes, which are assigned to the nucleus, are studied mostly in relation to small mutations, it has been suggested from time to time that they are concerned only with the development of such minor characters and that the more fundamental qualities of the organism are fixed in the cytoplasm. This can hardly appeal to one who thinks the question through. The impression rests rather on the present limitations of our methods of study than on the limitation of gene action itself. We can not test by current experimental methods the effect of genes on cytoplasm of too remote origin.

The location of genes in the chromosomes, the proof of their linear order, the association of somatic characters with definite points in the chromosomes, in short, the whole development of the gene theory is one of the most spectacular and amazing achievements of biology in our times. The embryologist, however, is concerned more with the larger changes in the whole organism and its primitive systems of organs than with the lesser qualities known to be associated with genic action. As Just remarked in the symposium this morning, he is interested more in the back than in the bristles on the back and more in eyes than in eye color.

Now that the necessity of relating the data of genetics to embryology is generally recognized and the "Wanderlust" of geneticists is beginning to urge them in our direction, it may not be inappropriate to point out a danger in this threatened invasion.

The prestige of success enjoyed by the gene theory might easily become a hindrance to the understanding of development by directing our attention solely to the genom, whereas cell movements, differentiation and in fact all developmental processes are actually effected by the cytoplasm. Already we have theories that refer the processes of development to genic action and regard the whole performance as no more than the realization of the potencies of the genes. Such theories are altogether too one-sided.

Whether we accept the plasmon concept or not, we are obliged, for reasons above stated and others as well, to assign to the cytoplasm of every egg specific characters, which are different in each species of organism. In the egg there are characteristic local differentiations, which are frequently of the nature of inclusions, but after these are all accounted for, the specific character of the cytoplasm still persists in the ground substance.

Living protoplasm is a complex mixture of substances deriving its properties not merely from their chemical nature but also from their arrangement in space. Nearly all are agreed that it is to the protein constituents of protoplasm that we must look for specific characters, though there are also specific carbohydrates and lipoids.

Much has been learned about the chemistry of proteins since the turn of the century, and about their physical properties and structure. Accordingly, on a recent occasion[6] I made the attempt, taking heart from Needham and others, to refer the changes in the developing organism to the conditions imposed by the configuration of the protein molecule and its accompanying chemical and physical activities. Lest you take me to task for resorting to such crude conceptions, look at the biochemists and their zoomorphisms, their protein molecules with backbone, head, tail, limbs and even back and belly, as well as right and left sides.

It was suggested that the dipole character of these molecules would tend to orient them within the cell, possibly with respect to the point of attachment in the ovary, thus bringing to expression the primary polarity of the egg. Opposite chemical properties at the two ends would set up different reactions resulting in the formation of different substances which are carried to opposite poles by electrophoresis. Two complementary fields or material gradients would thus be formed, each extending from a region of maximum concentration at one pole to a region of minimum concentration at the other. These materials, as well as substances of genic origin entering the cytoplasm from the nucleus, would start up new reactions of varying regional intensity in the side chains of the protein molecules, according to the concentration of the primary gradients. Thus new centers and fields of chemical activity would be set up locally, and in each such region new reactions would take place with other side chains, the relative velocities of these reactions being of significance.[7] The result would be a

[6] Harvard Tercentenary Conference.

[7] R. Goldschmidt, "Physiol. Theorie d. Vererbung." Berlin, Springer, 1927.

greater and greater local diversity of action, with accompanying local differentiation of cells, as the original egg became more and more divided. This latter process has often been referred to as segregation, but it is more correct to call it localization, for it seems to be an essential of the developing organism that, while new differentiating substances are formed, all cells retain not only in their nuclei but also in their cytoplasm the same fundamental specific characters as are possessed by the egg cell. In other words, some of the specific protein molecules, with their potentialities for characteristic arrangement, remain unchanged throughout the organism.

The chemical changes may be assumed to be accompanied by changes in molecular configuration involving the constants of atomic spacing. Hence through the action of crystallization forces, new internal stresses and strains arise, which are relieved by change in shape of the cells. The movements of gastrulation, the formation of the medullary plate and its rolling up to form a tube may be ascribed to the action of such forces.

Differentiations are in a sense, then, the by-products of protoplasmic activity and are accompanied by movements involving change of form. After the chemical changes have gone to a certain point, they tend more and more to inhibit other local reactions, and finally the cell becomes so loaded with secondary material that reverse changes no longer occur. It is customary to speak of regions, cells or cell groups, in which changes have proceeded so far, as "determined." In my opinion this expression were best dropped from the language of embryology, for there is no criterion for finding out when this condition is reached, if indeed it ever is. It is never possible to know whether some new set of conditions to which a developing part may be subjected may not undo what seems to have been already done irrevocably.

The striking experiment described by Schottó at the present meeting is a case in point. Here the regenerating blastema of the limb or tail of an amphibian, when placed in the eye of a frog larva from which the lens has been removed, differentiates into a lens. Already "determined" to form cartilage, bone and muscle in a certain definite configuration, this tissue, nevertheless, under the new and radically different conditions obtaining in the eye chamber, forms a crystalline lens, a structure heretofore known to develop either directly or indirectly only out of ectodermal epithelium.

Substances that react with the living protoplasm in the above way may arise from many sources. They may diffuse into the oocyte from maternal tissues; they may arise from the genes in the nucleus; they may come from organizers, *i.e.*, from other cells in close contact with the cells affected; they may be transported in later stages through the circulating body fluids (hormones), and finally they may come from the external medium. There is no reason to think that there is any fundamental difference in the action, on the living protoplasm, of substances derived from these various sources. Much depends, however, upon the time at which the protoplasm is most sensitive to their action.[8]

The importance of substances of genic origin lies in their continuous source of supply and in their transmissibility through generations. Organizers have come into prominence through the dramatic manner in which they have demonstrated epigenetic development at a time when the tendencies of thought were in the direction of preformation. Their most striking action, still veiled in mystery, lies not in the induction of a particular organ here or there, but in making plastic material form a harmoniously constructed embryo.

The discovery that various things could be substituted experimentally for the organizer has led to the effort to isolate a pure substance that will have the same effect. Likewise the discovery, in the body fluids of insect larvae, of factors mediating the action of genes has led to the search after their chemical nature.[9] This has been stimulated further by the circumstance that certain hormones known to have definite effects on the developing organism, such as thyroxin and the sex hormones, have been isolated in pure form and are of known structural formula. The very delicate and constant effects of these substances on development have been revealed in studies from many different quarters. All this is to the good, since if one substance taking part in a reaction is known, the chances of finding out what the other substances are and what the nature of the reaction itself is are much improved. However, it must not be lost sight of that we still know practically nothing of the actual changes involved in differentiation. Genetics by itself will not solve this problem. To accomplish this will require all the ingenuity of the embryologist, using the most refined methods of physics, chemistry and general physiology, not only those of the present but many others still to be invented.

Such features as pigmentation and pigment pattern in particular demonstrate the interaction of genes and hormones. The work from the Whitman Laboratory at the University of Chicago by Lillie and collaborators shows how rates of growth, genic action, rhythms of production of hormones, threshold values, all con-

[8] F. E. Lehman has discussed this question recently in a thoughtful address. *Die Naturwissenschaften*, 24: 401–407, 1936.

[9] A. Kühn, *Wissenschaftliche Woche z. Frankfurt a. M.*, Sept. 2–9, pp. 37–48, 1934.

tribute to the establishment of plumage patterns in birds. This deserves a high place among the achievements of experimental morphogenesis. Similar work on wing patterns in the Lepidoptera by Kühn and his associates in Göttingen has yielded comparable results. Such studies lend themselves admirably to the elucidation of quantitative relationships.

The form of gourds and of many other organic structures may be referred to relative growth rates, as Sinnott has clearly shown, and those features are likewise amenable to quantitative study. Here the unit character is not a particular form itself but a relative growth rate resultant in this form. At least four different types of form determination have been recognized in this group and are independent of each other in inheritance. "The genes which control them evidently differ in the time at which the major effect is produced and in the character of the effect itself."[10]

Growth is peculiarly susceptible to conditions imposed from without, particularly food, but growth rates are dependent also upon hereditary constitution. By means of heteroplastic grafting between species having very different growth rates, it is possible to show how the growth rate of any particular organ or part may be modified by associated structures and in this way to study quantitatively the interplay between hereditary and environmental factors of development.

A new method of study of protoplasmic structure is that of x-ray diffraction, and its possible applicability to embryonic differentiation is now in the offing. This whole field is but another romantic adventure of modern physics, though not so well known as some of the others of a more speculative nature. It is only twenty-five years since v. Laue's discovery that crystals could be used as diffraction gratings for x-rays. Applied at first to the study of crystals of some of the simpler inorganic salts belonging to the regular system, the method was soon extended to more complex salts and organic compounds. Cellulose, chitin and some of the simpler or denatured proteins have also yielded to this method of attack on the problem of their atomic arrangement. Even a few of the living tissues, particularly those occurring in fibrous form, such as tendon, muscle and nerve, have given clear diffraction pictures, now that very powerful x-ray tubes with appropriate accessories, necessitating only short exposures, are available. At the meeting of the British Association last September, according to a brief report in *Nature*, Dr. Mathieu gave a paper on what might be termed x-ray cinematography, in which the change in atomic spacing occurring in the nitration of cellulose was demonstrated.[11] Surely it is not too much to hope that some of the changes taking place in embryonic differentiation may some day be similarly revealed.

I have come to the close of a rather rambling discourse and can scarcely claim proof for many of the assertions made. If they seem to be vaguely general and to lack clarity, consider the following words of Max Planck:

> We must never forget that ideas devoid of a clear meaning frequently gave the strongest impulse to the further development of science. The idea of an elixir of life or of the transmutation of base metals gave rise to the science of chemistry; that of perpetual motion to an intelligent comprehension of energy; the idea of the absolute velocity of the earth gave rise to the theory of relativity, and the idea that the electronic movement resembled that of the planets was the origin of atomic physics. These are indisputable facts, and they give rise to thought, for they show clearly that in science as elsewhere fortune favors the brave.[12]

OBITUARY

ELIHU THOMSON[1]

No obituary notice can adequately express the significance of the life and accomplishments of such a man as Elihu Thomson, nor indeed is this a serious lack, for his name and fame are already deeply rooted in our American traditions of success and of technological progress. For purposes of record, however, and as a tribute to our colleague, who was so affectionately called "The Professor" by all his friends, there is presented the following biographical notice.

Elihu Thomson was born in Manchester, England, on March 29, 1853, son of Daniel and Mary Rhodes Thomson. The family moved to America when he was five years old, settling in Philadelphia. Progressing rapidly in elementary schooling, he was ready to enter the Central High School at the age of eleven. The rules of this school, however, required him to wait until he was thirteen to enter, and he employed the intervening two years in reading and experimenting in the new and fascinating field of electricity.

Once admitted to the high school, his academic progress was rapid. Graduating at eighteen, he was immediately made an instructor in physics, then an assistant professor at twenty and a full professor at

[10] E. W. Sinnott, *The American Naturalist*, 70: 245–254, 1936.

[1] Incorporating parts of an article in *The Technology Review*, Vol. 33, January, 1931.

[11] W. T. A., *Nature*, 138: 824–825, 1936.

[12] M. Planck, "The Philosophy of Physics," p. 112. Translated by W. H. Johnston. New York, Norton and Co., 1936.

twenty-three. Even at this early age he had become a fascinating lecturer on experimental electricity at the Franklin Institute, and had begun his remarkable series of inventions which were to play so basic a part in the development of the electrical industry.

The chronology of some of this earlier important work is: 1875, demonstrated wireless waves and their transmission to a distance through walls and floors (antedating Hertz by at least a decade); 1876, demonstrated his first electric generator; 1877, invented the centrifugal separator for cream and other liquids; 1879, invented the 3-coil automatically regulated arc dynamo, the 3-phase generator and the system of electric power transmission which comprises a step-up transformer at the source of power, transmission over a high tension line and a step-down transformer at the place of power consumption; 1881, invented the magnetically operated lightning arrestor; all these and more before the age of thirty!

In 1880, Professor Thomson left the teaching career to become electrician for the American Electric Company in New Britain, Connecticut. In 1882, with his former fellow-professor at Central High School, Edwin J. Houston, he formed the Thomson-Houston Company in New Britain. A year later this new company moved to Lynn, Massachusetts, with 184 employees and a rapidly growing business in arc-lighting, electric railway and later developments. Within ten years it had grown to a concern employing 4,000 persons in Lynn and had established foreign companies, notably the great Thomson-Houston Company of England. In all these developments, Professor Thomson's right-hand colleague and close friend was Edwin W. Rice, Jr., one of his former pupils in Central High School and destined to become president of the General Electric Company.

In 1892, the Thomson-Houston Company of Lynn combined with the Edison Electric Company of Schenectady to form the General Electric Company. Professor Thomson remained at Lynn, living in Swampscott, as head of the Thomson Research Laboratories. Under the business leadership of President Charles A. Coffin and the technical leadership of Thomson and Rice, the new company grew and prospered enormously.

I pass now to two of the most important and characteristic of Professor Thomson's discoveries. The first of these is that process of electrical welding whereby the welded surfaces were fused and united by the heat developed on account of the resistance in the contact between them. This method of welding has come into enormous use in industry, and the indications are that it will be even more used in the near future. As examples in widely different fields may be mentioned the welding of seamless metal tubing, the attachment of filaments and other electrodes in incandescent lamps and vacuum tubes, and the fastening together of most of the parts of the new Ford automobile. In the former of these applications it may be interesting to know that a single manufacturer had manufactured, a few years ago, about 24,000 miles of bedstead tubing by this process in a single year.

Professor Thomson was not the first to utilize an *arc* in welding. There was some previous arc, such as Slavianoff and DeMeritens, but the DeMeritens patent, which was fundamental, was bought on advice of Professor Thomson by the Thomson Electric Welding Company in the early days and, had arc welding developed within the life of the patent, that company would have controlled the arc as well as the electric resistance welding art.

Again, one of Professor Thomson's most fundamental discoveries was the principle of dynamical repulsion between a primary and secondary coil. This can be demonstrated by a variety of interesting lecture experiments, most of which were suggested and shown first by Professor Thomson himself. This scientific observation was developed by Professor Thomson into an alternating current repulsion motor, which is nothing more nor less than our ordinary induction motor, which is in almost universal use for small single phase motors.

In connection with this discovery there is interest in the following quotation from the *Electrical World* of May 28, 1887, commenting upon this work:

> It is, as yet, too early to assign to its proper place and limit the part which the alternating current will take in the electric arts. It has started on its career with most rapid strides, and it now only remains to devise means for its accurate measurement, regulation and distribution. Certain it is that Professor Thomson's brilliant paper can not fail to act as a powerful stimulus to those whose attention is now absorbed in the direction indicated, and the fruits of which will soon be noted. We hope that at a later meeting of the Institute Professor Thomson will give to the world his practical results, which he has only hinted at in the present paper.

These practical results are now seen, for example, in probably a million induction motors in daily use.

During the years 1885–1895 Professor Thomson was busily engaged with the development of electric meters, of which more than 4,000,000 are now in operation. It is these meters which tell you and the public service corporation the amount of your monthly electric bill, and for this invention Professor Thomson was awarded the Paris Meter Prize in 1890 at a competition held after the exposition of 1889.

As early as 1890 and continued intensively for half

a dozen years thereafter were a series of brilliant experiments on high frequency alternating currents, paving the way for many of the developments in wireless and other high frequency applications which are being so actively applied at the present time. He constructed the first high frequency dynamo, operating at frequencies of 30 to 40 times as great as any previously designed, and in connection with experiments with this type of electric power he designed also the first special high frequency transformers. While working in this field he discovered a method of producing still higher frequency alternating current from a direct current arc, by shunting the arc with inductance and capacity, thus discovering the method which played such an important rôle in wireless transmission up until its virtual replacement by electronic tube devices only within the past few years. This interesting method of producing alternating currents was actually applied to wireless telegraphy by Poulsen, and is therefore generally known as the Poulsen arc. Also in connection with these high frequency investigations, he made the important discovery that the insulating power of oils at these high frequencies is very much greater than at the ordinary low commercial frequencies, if this insulating power is measured in terms of the path at which a spark will pass. Just one other item can be mentioned in connection with his high frequency work, namely, the fact that he discovered and was the first to use the method of tuning electric circuits, which is, of course, absolutely fundamental to modern electrical communication systems.

Among Professor Thomson's other contributions, mostly embodied in his more than 700 patents, the following are mentioned to illustrate the scope of his interests: "uniflow" steam engine; automobile muffler; device for automatically guiding the roll of a player-piano (invented as part of the construction of his remarkable home-made pipe organ); methods of producing optical fused quartz; stereoscopic x-ray pictures; various electrical safety devices.

Probably no other American scientist has received such recognition by learned and professional societies. He received the three most notable scientific awards of Great Britain; the Hughes Medal of the Royal Society in 1916, the Lord Kelvin Medal of the English-speaking engineering societies in 1924, and the Faraday Medal of the Institution of Electrical Engineers of England in 1927. He was decorated with the red rosette of the Legion of Honor of France in 1889, and made chevalier and officer of this body. He twice received the Grand Prix at the Paris Exposition. On his eighty-second birthday he was the second American to receive the medal of honor of the Verein Deutscher Ingenieure. In America he has twice received the John Scott Medal of the city of Philadelphia; the Elliott Cresson Gold Medal and the Franklin Medal from the Franklin Institute; the Rumford Medal of the American Academy of Arts and Sciences; the John Fritz Medal of the four founder American engineering societies.

Among Professor Thomson's official positions in professional societies are presidencies of the International Electrotechnical Commission, the International Electrical Congress and the American Institute of Electrical Engineers. He was an active member of the National Academy of Sciences, the American Philosophical Society, the Franklin Institute, the American Academy of Arts and Sciences, the American Association for the Advancement of Science and the American Chemical Society. He also took an active and official interest in the Peabody Museum of Salem and the Public Library of Swampscott.

Professor Thomson retained a life-long interest in the Massachusetts Institute of Technology, where he was a lecturer in the department of electrical engineering, life member of the corporation, acting president from 1920 to 1922 and, until his disability from illness three years ago, a faithful member of its executive committee.

In commemoration of Professor Thomson's eightieth birthday in 1933, two great meetings were held in his honor, at which his friends gathered from far and near. One of these was at M.I.T. as a symposium and exhibition of electrical developments, followed by a dinner to many hundreds of guests. The other was a neighborhood celebration by his friends and associates of Lynn and Swampscott. It is a source of gratification that these testimonials were held while Professor Thomson was yet able to participate and enjoy them. For it was in the next year that he was stricken with influenza, followed by pneumonia, which left him with the increasing affliction of asthma and heart which ultimately led to his death, in quiet and peace, on March 13, 1937.

On May 1, 1884, Professor Thomson married Mary I. Peck, of New Britain, Connecticut. They had four sons, the late Captain Stuart Thomson, who died of war injuries in 1919, Roland D. Thomson, of Schenectady, N. Y., Malcolm Thomson, of Swampscott, who is a welding engineer in the Works Fabricating department, and Donald T. Thomson, of Rye, New York. Mrs. Thomson died in 1916, and on January 4, 1923, Professor Thomson married Miss Clarissa Hovey, the daughter of Theodore Hovey, of Boston, who survives him, after their years of close companionship and the last few years of her most devoted and able care of her stricken husband.

KARL T. COMPTON

RECENT DEATHS

Dr. Milton J. Greenman, since 1905 director of the Wistar Institute of Anatomy, Philadelphia, died on April 7 at the age of seventy years.

Dr. Frederick C. Langenberg, metallurgist, vice-president in charge of research of the United States Pipe and Foundry Company, died suddenly on April 4. He was forty-seven years old.

Charles H. Haupt, of the Standard Oil Development Company, died on April 10 at the age of sixty-seven years. Mr. Haupt was formerly an assistant professor in civil engineering at the University of Pennsylvania under Professor Lewis M. Haupt, his uncle, who died a month ago.

Dr. Allan Fulson Odell, chemical director of the E. I. du Pont de Nemours plant at Arlington, N. J., died on April 10. He was fifty years old. From 1909 to 1913 Dr. Odell was an assistant professor in chemistry at the Louisiana State University, leaving the university to become a research chemist for Charles Pfizer and Company.

Professor Dr. Heinrich Bechhold, director of the Institute for Research in Colloid Chemistry at Frankfurt-a-M., died on February 18. He was the author of "Colloids in Biology and Medicine," a book which was translated by Dr. J. G. M. Bullowa.

A correspondent writes: "Dr. Katharine Jeannette Bush, the first woman to be granted the doctor's degree in zoology at Yale University, died at Hartford, Conn., on January 19, following an incapacitating illness of nearly ten years. She had just passed her eighty-first birthday. Her professional career began in 1881, as assistant to the late Professor A. E. Verrill in studies on the marine invertebrates collected by the U. S. Fish Commission off the Atlantic Coast and in the Gulf Stream. She was later associated with the U. S. National Museum and with the Peabody Museum of Yale. Her publications consisted of systematic papers on the classification of annelids and mollusks, with descriptions of many new species. She is survived by one sister, the wife of Professor Wesley R. Coe, of Yale University."

Nature records the death of Professor J. H. F. Douvillé, formerly professor of paleontology in the National School of Mines, Paris; of Sir Albert Kitson, director of the Geological Survey of the Gold Coast in 1913–30, on March 8, aged sixty-nine years; of Professor C. J. Lewis, emeritus professor of public health in the University of Birmingham, on February 6; of Professor F. P. F. Ransom, formerly professor of pharmacology in the University of London, on February 22, aged eighty-seven years; of Sir James Currie, chairman of the governing body of the Imperial College of Tropical Agriculture, Trinidad, and director of the Empire Cotton Growing Corporation, on March 17, aged sixty-eight years, and of Professor J. A. Gilruth, formerly professor of veterinary pathology in the University of Melbourne, lately chief of the Division of Animal Health of the Commonwealth Council for Scientific and Industrial Research, on March 4, aged sixty-six years.

SCIENTIFIC EVENTS

BROADCASTS OF THE 1937 ECLIPSE

The National Geographic Society–U. S. Navy Expedition to observe the total eclipse of June 8 from one of the Phoenix Islands will be broadcast over the coast-to-coast networks of the National Broadcasting Company. Professor S. A. Mitchell, director of the Leander McCormick Observatory of the University of Virginia, will be the leader. He will be assisted by Captain J. F. Hellweg, superintendent of the U. S. Naval Observatory, who will have charge of the Navy's participation; Dr. P. A. McNally, director of the Georgetown College Observatory; Professor F. K. Richtmyer, Cornell University; Dr. Irvine C. Gardner, National Bureau of Standards; Dr. Theodore Dunham, Jr., Mt. Wilson Observatory; John E. Willis, U. S. Naval Observatory; Charles Bittinger, Washington; Charles G. Thompson, New York; R. H. Stewart, National Geographic Society; George Hicks and Engineers Brown and Adams, of the National Broadcasting Company.

The schedule of broadcasts, three of which have already been given, follows:

March 30: George W. Hutchison, secretary, National Geographic Society, ''Announcing the Eclipse Expedition.''

April 10: ''Science Prepares for an Eclipse.'' Admiral William D. Leahy, chief of Naval Operations; Dr. Lyman J. Briggs, chairman, Research Committee, National Geographic Society; and the Rev. Paul A. McNally, director, Georgetown College Observatory.

April 15: ''Radio and the Eclipse.'' Announcer George Hicks opened the program, followed by Dr. Theodore Dunham, of Mt. Wilson Observatory, N.B.C. Engineers Brown and Adams and R. H. Stewart, National Geographic Society photographer.

April 28: ''Scientists and Sailors Follow the Sun.'' Dr. John O. LaGorce, vice-president of the National Geographic Society, from Washington, Captain J. F. Hellweg, from Honolulu, and Dr. S. A. Mitchell, on board *S.S. Mariposa*, Los Angeles, a few hours prior to the sailing of the main scientific group.

May 6: "The Eclipse Expedition Weighs Anchor." Entire program from deck of *U.S.S. Avocet* at Honolulu. Dr. Gilbert Grosvenor, president of the National Geographic Society; Governor Poindexter, of Hawaii; Admiral Orin G. Murfin, commandant, Navy Yard, Pearl Harbor, and Dr. S. A. Mitchell. Appropriate Hawaiian music as background.

May 10: "At Sea with the Eclipse Expedition." Mid-ocean auditions from the *U.S.S. Avocet*. Members of the expedition personnel and ship's crew—preparations for "Crossing the Line."

May 16: "The Eclipse Expedition Arrives in the South Seas and Chooses Its Island." The broadcast will be direct from the island and will include general description of the landing of the expedition.

May 22: "The Eclipse Expedition at Home in the South Seas." Academic discussion by the scientific personnel and general discussion and interesting sidelights by the non-scientific personnel.

May 25: "News from Home" and "Entertainment for the Eclipse Exiles." The program opens in New York with music (seven minutes) and press radio news (five minutes). It then shifts to Washington, where eight minutes will be devoted to messages to the expedition from the National Geographic Society and to personal messages to individuals. The program will then return to New York for ten minutes of music and variety.

May 30: "The Eclipse Expedition Celebrates Decoration Day in the South Seas." Reporting news items from the expedition, interesting observations and personal messages from individual members.

June 1: Duplicate of Broadcast of May 25.

June 7: "Dress Rehearsal for the Eclipse." Roll call and a quick report from each member as to his final preparations.

June 8: Preliminary to the main program (which will follow several hours later) primarily for the purpose of establishing contact channels for the principal broadcast. Announcer George Hicks will make a general commentary, discuss the weather, etc.

June 8: "Description of the Total Eclipse of the Sun from the Area of Totality in the South Seas." Announcer George Hicks and members of the scientific staff.

June 8: "What the Eclipse Expedition Saw." Ten minutes devoted to a brief report to the National Geographic Society by Dr. S. A. Mitchell and his scientific staff, following which the program shifts to Washington, where National Geographic Society officials reply for five minutes.

APPOINTMENTS AND PROMOTIONS AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PROMOTIONS and new appointments have been made at the Massachusetts Institute of Technology as follows:

Members of the faculty promoted to the rank of full professor are: Professors Ralph D. Bennett and Edward L. Bowles, department of electrical engineering; Karl D. Fernstrom, department of business and engineering administration; Philip Franklin, department of mathematics; Murray P. Horwood, department of biology and public health; George Scatchard, department of chemistry, and Edward R. Schwarz, department of mechanical engineering.

Promoted from assistant professorships to associate professor are: Edward S. Taylor and Arthur L. Townsend, department of mechanical engineering; Raymond D. Douglass, department of mathematics; Bernard E. Proctor, department of biology and public health; John B. Wilbur, department of civil and sanitary engineering; Murray F. Gardner, Richard H. Frazier and Parry H. Moon, department of electrical engineering, and John Wulff, Wayne B. Nottingham and Nathaniel H. Frank, department of physics.

Members of the staff promoted to the rank of assistant professor are: Herbert C. Moore and Charles W. MacGregor, department of mechanical engineering; Ernest N. Gelotte, department of architecture; Robert S. Harris, department of biology and public health; Ronald H. Robnett, department of business and engineering administration; George G. Marvin and Edmund L. Gamble, department of chemistry; Arthur C. Ruge, department of civil and sanitary engineering; William M. Hall, department of electrical engineering; Paul C. Eaton, department of English; Robert H. Cameron, department of mathematics, and Morris Cohen, department of mining and metallurgy.

Promoted to the rank of instructor are: Archibald Williams, business and engineering administration; George A. Akin, chemical engineering; Edward R. Livernash, department of economics and social science; Henry E. Kiley, Leopold R. Michel, Blake Mills and Roger L. Putney, department of mechanical engineering, and Reinhardt Schuhmann, Jr., department of mining and metallurgy.

New appointments include: H. W. Fairburn as assistant professor of geology; Niels H. Larsen, instructor in architecture; Robert V. Lukes, instructor in chemical engineering; Alberto F. Thompson, Jr., instructor in chemistry, and James G. Baker, assistant director of the School of Chemical Engineering Practice.

GRANTS AWARDED BY THE AMERICAN PHILOSOPHICAL SOCIETY

THE committee on research of the American Philosophical Society, at meetings held on December 11 and February 12, made grants as follows:

Davenport Hooker, University of Pittsburgh, for functional and morphological studies of human prenatal development .... $ 500

Ralph A. Beebe, Amherst College, for the direct measurement of heats of adsorption at low temperatures and the measurement of rates of adsorption under accurately controlled pressures of gas 1,000

Laurence Irving, University of Toronto, for the study of physiological adjustments of respirations in diving mammals $1,050

Robert K. Enders, Swarthmore College. The mammals of the Chiriqui region of Panama, with reference to their distribution, affinities, faunal relationships and life histories; to collect material for anatomical and embryological studies 800

Earle Radcliffe Caley, Princeton University, for the application of chemistry to archeology—the restoration and preservation, chemical examination of ancient objects, etc. 2,250

Joel Stebbins, University of Wisconsin, for the development and improvement of photo-electric amplifier; application to photometry and colorimetry of stars; study of space-reddening and of dimensions and constitution of the galaxy 1,000

Harold O. Burdick, Alfred University, for investigation of the rôle of the tubo-uterine junction to determine if this region acts like a valve which is directly or indirectly controlled by hormones 500

Murray B. Emeneau, Yale University, for the continuation of the study of Dravidian (and Munda) languages of India 2,000

James A. G. Rehn, Academy of Natural Sciences, for distributional investigation of the Orthoptera occurring in certain areas of New Mexico, Arizona, Nevada and California 500

Alexander Weinstein, Columbia University, for multiple-strand crossing over and coincidence 1,500

F. B. Isely, Trinity University, Texas, for the study of the ecology of Orthopterous insects 600

Hertha Sponer, Duke University, for investigation of absorption spectra of polyatomic molecules, especially in the photographic infra-red 800

Karl F. Herzfeld, Catholic University of America, for theoretical investigation of the absorption spectra of organic compounds 1,200

William Bell Dinsmoor, Columbia University, for a detailed study of the history, design, decoration and construction of the architectural monuments of ancient Greece in the age of Pericles 1,500

Anna R. Whiting, University of Pennsylvania, for a study of genetically different eye and body colors in mosaic males of *Habrobracon juglandis* (Ashmead) 500

Ralph E. Cleland, Goucher College, for the continuation of joint study of the cyto-genetics and phylogeny of Oenothera (Onagra), the evening primrose 1,500

Rudolf Höber, University of Pennsylvania, for the study of characteristic effects of organic ions on the secretory power of the isolated perfused liver 300

Albert T. Volwiler, Ohio University, for the preparation for publication of the correspondence between President Benjamin Harrison and James G. Blaine, his secretary of state 1,000

Enos E. Witmer, University of Pennsylvania, for the tabulation and study of the energy levels of the asymmetrical rotator 500

DEDICATION OF THE NEW BUILDING OF MELLON INSTITUTE

The new building of Mellon Institute, which will be dedicated on May 6, was described in the issue of SCIENCE for April 9. The program in connection with the dedication ceremonies has now been announced.

At the formal dedication of the building in the afternoon of May 6 in Carnegie Music Hall, with Dr. Edward R. Weidlein, director of the institute, presiding, addresses will be given by three Nobel laureates: Dr. Irving Langmuir, chemistry; Dr. H. C. Urey, physical chemistry, and Dr. W. P. Murphy, medicine. Brief addresses will be given by Andrew W. Mellon and Richard K. Mellon, representing the founders.

The trustees' dinner will be held in the evening of the same day, among the speakers being Dr. Benjamin T. Brooks, Dr. Karl T. Compton and Dr. F. C. Whitmore. A. V. Davis, chairman of the board of the Aluminum Company of America, will be toastmaster. Trustees of the institute comprise John G. Bowman, president, Dr. Weidlein, vice-president, Henry A. Phillips, secretary-treasurer, Andrew W. Mellon and Richard K. Mellon.

There will be a symposium on "Recent Progress in Science," on the morning of Friday, May 7, in Carnegie Music Hall. The speakers will include Dr. G. O. Curme, Jr., Dr. F. B. Jewett, Sir Frederick Banting and Dr. W. W. G. Maclachlan.

The new building, which it has taken six years to complete, is to be dedicated to science and humanity in honor of Andrew W. and Richard B. Mellon, founders of the institution, who in 1911 gave support to the research fellowship system advanced by the late Robert Kennedy Duncan by establishing a specific department at the University of Pittsburgh and in 1913 placed the system on a permanent basis with the organization of Mellon Institute.

The detailed program for the dedicatory week follows:

Thursday, May 6, 9:00 A.M., assembly of out-of-town guests at the institute's new building; 10:00 A.M., preview of the building for former fellows, past and present research donors and other guests; 12:00 M., luncheon, Hotel Schenley, and luncheon sponsored by the Robert Kennedy Duncan Club for former fellows, University Club; 2:00 P.M., dedication exercises, Carnegie Music Hall; trustees' dinner, 7:30 P.M., William Penn Hotel.

Friday, May 7, 10:00 A.M., Symposium on Recent Progress of Science, Carnegie Music Hall; 12:30 P.M., luncheon for visiting scientists, University Club; 2:30 P.M., special meeting of Robert Kennedy Duncan Club, Institute Auditorium, and inspection of the new building and special exhibits; 7:00 P.M., group dinners for visiting scientists.

The new building will be open to the public on Saturday, May 8, from 10:00 A.M., to 10:00 P.M., and on Sunday, May 9, from 1:00 to 7:00 P.M.

SCIENTIFIC NOTES AND NEWS

THE American Philosophical Society will hold a general meeting in the hall of the society, Independence Square, Philadelphia, on April 22, 23 and 24. There will be five sessions for the reading of scientific papers at which the presiding officers are: President Roland S. Morris and the three vice-presidents; Drs. Edwin G. Conklin, Henry H. Donaldson and Robert A. Millikan. The Penrose Memorial Lecture on Friday evening will be given by Dr. Irving Langmuir, associate director of the Research Laboratory of the General Electric Company, who will speak on "The Surfaces of Solids and Liquids."

THE Franklin Institute of Philadelphia has awarded Franklin medals to Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology, and to Dr. Peter J. W. Debye, director of the Kaiser Wilhelm Institute of Physics in Berlin. The medals, with certificates, will be presented on the Medal Day of the institute, which has been set for May 19.

PRESENTATION of the Desmond FitzGerald Medal of the Boston Society of Civil Engineers to Professor Albert Haertlein, of the Harvard Graduate School of Engineering, was made at the annual dinner on March 17.

D. S. JACOBUS, advisory engineer to the Babcock and Wilcox Company, New York City, has been awarded the Morehead Medal of the International Acetylene Association.

DR. MILO HELLMAN, professor of dentistry at Columbia University and research associate in physical anthropology at the American Museum of Natural History, on March 15 was honored with a citation for "diligence, experience and skill, observational precision and breadth of understanding" by the Associated Foundations in the laboratory of anatomy of Western Reserve University. The citation was signed by Dr. T. Wingate Todd, for the anatomical laboratory; Dr. Wilton M. Krogman, for the anthropological division, and Dr. B. Holly Broadbent, for the Bolton Fund.

AT the annual convocation of McGill University the doctorate of laws will be conferred on Sir Josiah Stamp, the economist. Sir Josiah was last year president of the British Association for the Advancement of Science.

DR. HORACE W. STUNKARD, professor of biology at New York University, formerly corresponding secretary of the New York Academy of Sciences, has been elected to succeed the late Dr. George H. Sherwood as president of the academy.

DR. KARL S. LASHLEY, of Harvard University, was elected president of the Eastern Branch of the American Psychological Association at the spring meeting held at Vassar College on April 3. He succeeds Dr. Samuel W. Fernberger, of the University of Pennsylvania.

CHARLES M. ROGERS was elected president of the Astronomical Society of New Orleans at the annual meeting on March 31. He succeeds Dr. J. Adair Lyon.

AT the University of Cincinnati the following officers of Sigma Xi for the years 1937–38 and 1939 have been elected: *President*, Dr. R. C. Gowdy, professor of physics; *Vice-president*, Dr. H. W. Robinson, assistant professor of biochemistry, and *Secretary-Treasurer*, Dr. S. B. Arenson, associate professor of chemistry.

DR. EDITH MARION PATCH, since 1904 entomologist at the Maine Experiment Station at Orono, will retire in June.

DR. LOWELL J. REED, since 1925 professor of biostatistics at the Johns Hopkins University, has been appointed dean of the School of Hygiene and Public Health, succeeding Dr. Allen W. Freeman, who has been connected with the school since 1921 and who has been dean since 1934.

DR. ANTONIO G. SISON, professor of medicine, College of Medicine, University of the Philippines, Manila, has been appointed dean of the college to succeed Dr. Fernando Calderon, who retired in October.

DR. C. F. ROOS, professor of economics at Colorado College and research director of the Cowles Commission for Research in Economics, has resigned to accept a position as director of research with the Mercer Allied Corporation.

DR. DONALD B. GOULD, who for six years has had charge of the department of geology and geography at Cornell College, Mount Vernon, Iowa, has been appointed to a professorship at Colorado College.

AT Princeton University, Professor William T. Thom, Jr., has been appointed to the Blair chair in geology, succeeding the late Professor Alexander H. Phillips; Associate Professor Elmer G. Butler, present chairman of the department of biology, has been named to the Class of 1877 professorship of biology, and Professor Alan W. C. Menzies has been promoted to the Russell Wellman Moore professorship of chemistry. Other promotions to professorships include Associate Professor Clodius H. Willis, of the School of Engineering, and Associate Professor N. Howell Furman, of the department of chemistry; to associate professorships Assistant Professors Gaylord P. Harnwell, of the department of physics, and Richard H. Wilhelm and John C. Whitwell, of the department of en-

gineering. Harry H. Hess, of the department of geology, has been promoted to an assistant professorship.

MEMBERS have been elected to the board of trustees of the Rockefeller Foundation as follows: President Harold Willis Dodds, of Princeton University; Dr. Douglas Southall Freeman, of Richmond, Va., president of the board of trustees of the University of Richmond and visiting professor of journalism at Columbia University; Dr. Herbert Spencer Gasser, director of the Rockefeller Institute for Medical Research, and Dr. Alfred Newton Richards, professor of pharmacology at the University of Pennsylvania.

DEAN W. F. RUDD, of the Medical College of Virginia, has been placed in charge of a study of certain problems in connection with reorganization plans contemplated in the School of Pharmacy at Columbia University to be put into effect upon the retirement of the dean at the end of the present session. He plans to spend alternate weeks in New York City. Associated with him as advisers will be Dr. W. G. Crockett, president of the American Association of Colleges of Pharmacy, and Dr. Ernest Little, of Rutgers University, chairman of the executive committee of the association.

THE Committee on Scientific Research of the American Medical Association announces the award of a grant to Dr. CoTui, of the Laboratory of Experimental Surgery of the New York University College of Medicine, for the study of the relation between pyrogen and the Shartzman phenomenon.

THE J. T. Baker Chemical Company Analytical Research Fellowship, Eastern Division, has been awarded for the academic year 1937–38 to Robert C. Newton, for the past two years research assistant in chemistry at Princeton University. Mr. Newton will work under the direction of Professor N. H. Furman.

PROFESSOR WILL E. EDINGTON, of DePauw University, president of the Indiana Academy of Science, has appointed the following committee to cooperate with the American Association for the Advancement of Science at its winter meeting in Indianapolis: Amos W. Butler, Indianapolis, one of the founders of the academy, *chairman;* Frank B. Wade, Shortridge High School, Indianapolis, *vice-chairman;* T. E. Mason, J. J. Davis, A. A. Potter, H. R. Kraybill, T. M. Bushnell, Purdue University; R. R. Ramsey, S. S. Visher, F. Payne, C. A. Malott, Indiana University; W. M. Blanchard, Fowler D. Brooks, DePauw University; H. G. Nester, Butler University; M. S. Markle, Earlham University; S. E. Perkins, III, Indianapolis, and M. W. Lyon, Jr., South Bend.

THE thirteenth William Thompson Sedgwick Memorial Lecture of the Massachusetts Institute of Technology will be delivered on April 23 by Selskar Michael Gunn, vice-president of the Rockefeller Foundation and director of public health work of the foundation in the Far East. The subject of the lecture will be "Public Health in China."

THE second Hughlings Jackson Lecture of the Montreal Neurological Institute was given on April 14 by Dr. Karl S. Lashley, professor of psychology at Harvard University. He spoke on "Factors Limiting Improvement after Central Nervous Injuries."

DEAN E. P. LYON, emeritus of the Medical School of the University of Minnesota, gave an illustrated address before the Sigma Xi Club of the University of Florida on March 31. His subject was "The Medical Sciences and Education in the Soviet Union."

DR. HERBERT M. EVANS, professor of anatomy and Morris Hertzstein professor of biology at the University of California Medical School, will address the Minnesota Pathological Society on April 20, on vitamins. He will discuss the same subject the following evening under the Clarence Martin Jackson Lectureship sponsored by the Phi Beta Pi medical fraternity.

DR. NIELS BOHR, Hitchcock professor this year at the University of California, Berkeley, spoke on March 19 on "Transmutations of Atomic Nuclei," under the joint auspices of the California Chapter of the Society of Sigma Xi and the department of physics of the University at Los Angeles.

THE reorganized Minnesota Academy of Science will hold its fifth annual meeting at University Farm, University of Minnesota, on April 17. During the past year the academy has instituted the Junior Academy plan for the secondary schools of the state. Section programs have been arranged for the one-day session. These include the biological, physical and science education groups. Speakers and topics on the general program include from the University of Minnesota: "A Word of Welcome," Dr. Walter C. Coffey, dean of the department of agriculture; "Drought, Dust Storms and Desolation," Professor D. H. Davis; "Some Recent Advances in Clinical Physiology," Dr. Irvine McQuarrie, and "The Fate of the Indigenous," Dr. A. N. Wilcox. A public lecture has been planned for the evening session. The speaker will be Dr. H. K. Hayes, chief of the Division of Agronomy and Plant Genetics. Dr. Hayes returned recently from a year in China, where he directed the agronomic research of the country. He will speak on "Some Observations on Life in China."

THE American Association of Museums will meet in New Orleans on May 3, 4 and 5. Two afternoons and two evenings will be given to the sessions of the sections; one afternoon will be free, and the last evening will be devoted to the annual dinner. The programs

of the sections are being organized by the following chairmen: Meyric R. Rogers, St. Louis, Art; Hardinge Scholle, New York, History; Katherine Coffey, Newark, Instructors; Ned Burns, Washington, National and State Parks; Sarah Newmeyer, New York, Public Relations and Radio; H. L. Story, Boston, Registrars; Robert Glenk, New Orleans, Science; Charles R. Toothaker, Philadelphia, Technical, and John W. McCabe, Cleveland, Superintendents.

A UNITED STATES CIVIL SERVICE open competitive examination has been announced for psychologist (Public Relations), at a salary of $3,800 a year in the Forest Service, U. S. Department of Agriculture, Washington, D. C. Applications must be on file not later than May 3. The work of the position is "Under general supervision, to apply the principles and techniques of psychology in a program for securing intelligent public cooperation in the protection of forest areas from fire; to determine the origin of man-caused fires; to determine current attitudes in forest areas toward fire prevention and toward the policies and practices of the Forest Service; to develop various methods of securing more effective public responsiveness to protection measures, and to evaluate the effectiveness of such methods; to make trips to field units; to supply technical psychological advice as consulting expert, and to perform other work of a related nature as assigned." Competitors will not be required to report for examination at any place, but will be rated on education and experience and on a thesis or discussion to be filed with application. The necessary application forms may be obtained from any first-class post office or from the United States Civil Service Commission, Washington, D. C.

THE Council on Physical Therapy of the American Medical Association has announced in its report of the annual meeting that grants of limited sums, to aid in research, are available to those who have problems of merit in the field of physical therapy. Application should be made to the secretary of the Council on Physical Therapy, The American Medical Association, 535 North Dearborn Street, Chicago, Ill.

DENISON UNIVERSITY at Granville, Ohio, is celebrating on April 16 the fiftieth anniversary of the founding of the Denison Scientific Association. A correspondent writes: "It is not often that a school serving no more than 850 students at the most, and definitely labeling itself a College of Liberal Arts, has been able to maintain such a vigorous interest for so long a period. A good share of the credit for this record must go to *The Journal of the Scientific Laboratories* and to the sponsors and editors of the same, who have built up, over a period of fifty-two years, a journal which goes to the far corners of the earth and brings in, in return, a wealth of scientific material and contact not often met in similar institutions." The celebration consists of bringing back to the campus alumni who have attained prominence in various scientific fields. Dr. Carey G. Croneis, professor of paleontology at the University of Chicago, is to speak on "Science and the College."

WITH a view to the encouragement of postgraduate training in scientific research, chiefly in the graduate schools of Canadian universities, the National Research Council of Canada has awarded 47 scholarships for the year 1937–38. These include three fellowships at $700 each, 12 studentships at $600, and 27 bursaries at $500, all of which will be held in departments of science at the universities. Five other scholarships, tenable in the National Research Laboratories at Ottawa, will enable the holders, all of whom have already done postgraduate research at the universities, to gain experience in the field of industrial research before engaging in commercial work. Classified according to the departments of science in which the scholarship holders will work, the awards show that chemistry in its various branches heads the list with 25, physics comes next with 12, followed by 4 in biology, 2 in genetics, and one each in botany, geology, mathematics and mechanical engineering. Applications were received from graduates of 18 Canadian universities, and awards have been made which will enable the holders to work in the graduate schools of eight different universities in Canada, namely: Dalhousie, Laval, McGill, Montreal, Queen's, Toronto, Western Ontario and Saskatchewan.

DISCUSSION

COBALT—AN ESSENTIAL ELEMENT

SOME months ago Dr. H. G. Denham, chairman of the Council of Scientific and Industrial Research of New Zealand, visited Minnesota and among other things told of the amazing success which they have had in curing "bushsickness" in domestic animals in New Zealand by the addition of traces of cobalt salts to the diet of the animals. Dr. Denham stated that alfalfa might grow luxuriantly in a cobalt deficient area, but the animals suffered severe deficiency symptoms if fed only on the forage of that area. He stated that certain "iron" salts cured the disease, whereas "iron" salts from other sources failed to cure and that the same was true for "copper" salts, and in each instance the cure had been traced to small amounts of cobalt in those salts which produced the cures.

Some weeks later at the Chicago meeting of the National Academy of Sciences, during the discussion of a paper, I commented on Dr. Denham's statements, and pointed out that this study had added cobalt to the known "essential" elements. Much to my chagrin these statements were distorted in press reports of the academy meetings, and I and my laboratories at Minnesota were credited with this discovery. In so far as I could, I attempted to correct the false report, for we have made no studies of this sort at Minnesota. Nevertheless we were given the credit in the "Summary of Science for 1936" in the columns of one of the New York daily newspapers. Accordingly, I wrote Dr. Denham and asked him to prepare a short statement outlining the scope of the work and the essential findings which could be submitted for publication in the United States in order that credit may be given where credit is due. Dr. Denham's statement, submitted in response to my request, follows.

Ross Aiken Gortner
University of Minnesota

Cobalt Investigations in New Zealand

In the course of the Liversidge Lecture delivered at the recent bi-annual meeting of the Australia and New Zealand Association for the Advancement of Science by Mr. T. Rigg, director of the Cawthron Institute, the progress of the cooperative investigations of the Department of Scientific and Industrial Research of New Zealand and the Cawthron Institute in regard to cobalt deficiency in New Zealand was reviewed.

Mr. Rigg stated that at both Morton Mains, Southland, and Glenhope, Nelson, the use of cobalt drenches supplying 8 mg cobalt per week had been completely effective in preventing and in curing sheep ailment. Furthermore, in both localities the curative properties of drench materials, which in former years had given success in the treatment of stock ailment, had been shown to be dependent not on their iron content but on a relatively high content of cobalt. Nelson soil used with success in earlier experiments at both Morton Mains and Glenhope contained 56 parts per million of cobalt. Whangarei limonite (Reyburn's), which had been shown by B. C. Aston to be so beneficial in controlling "bushsickness" on the pumice soils of the North Island, contained likewise approximately 60 parts per million of cobalt. Other drench materials, which have not proved successful in the control of stock ailment of the bushsickness type, contained relatively little cobalt. At both Glenhope and Morton Mains, acid extracts of beneficial drench materials, carefully freed from iron, gave the same results as pure cobalt salts. Recent experiments of the chemistry department of the Department of Agriculture of New Zealand had likewise shown, in the case of typical bushsickness of the North Island, that carefully purified ferric ammonium citrate was non-effective in the control of bushsickness and that cobalt salts were highly beneficial.

Much work is now in progress to determine whether there is an actual deficiency of cobalt in the pastures, soils and animal organs of the areas affected with stock ailment. Investigations are not complete, but substantial evidence is being obtained of a low cobalt status associated with affected areas. Askew and Dixon in a paper presented at the same meeting and dealing with the cobalt status of animal organs at Glenhope and Morton Mains showed conclusively that the liver, pancreas and blood of affected sheep contained very much less cobalt than corresponding organs from healthy sheep. Frequently the amount of cobalt was one tenth in the case of livers of that associated with healthy sheep, *e.g.*, cobalt content of healthy livers 0.15 to 0.25 p.p.m. compared with 0.02 p.p.m. for affected sheep. The cobalt content of livers taken from sheep drenched with cobalt salts was approximately 0.20 p.p.m. on the dry basis, corresponding closely to the cobalt content of livers from healthy sheep killed at the freezing works.

Determinations of cobalt in pastures have not proceeded far enough to enable the position to be summarized, but in the case of Glenhope pasture there is every indication that the cobalt content of affected pastures is considerably lower than that of adjoining healthy pastures. One interesting feature of the pastures investigations is the rapid intake of cobalt by pasture plants, demonstrating the possibility of using small top-dressings of soluble cobalt salts in the treatment of affected pastures. The cobalt survey of New Zealand soils made by Miss E. B. Kidson in the main has confirmed a low cobalt status of soils in association with stock ailment. One or two soils, however, gave anomalous results. These results could possibly be explained on an assumption of difference in "availability," but so far attempts to determine available cobalt in soils have not proved successful. The soil results indicate that a low cobalt status of the soil is not always a satisfactory index of the need for cobalt supplements for stock.

H. G. Denham,
Chairman, Council of Scientific and Industrial Research for New Zealand

THERMODYNAMICS AND THE RATES OF COUPLED OR REVERSED REACTIONS

Thermodynamics can give us more valuable information concerning reaction velocities than is often suspected. It is of course true that with thermody-

namics alone it is impossible to obtain even an estimate of the absolute magnitude of a reaction velocity. This apparent weakness, due to the very nature of thermodynamics, is actually a power, since it enables us to establish theorems on reaction rates which are independent of the magnitude of these rates and of the intimate reaction mechanisms. The situation is indeed quite similar with most of the other physical or chemical quantities with which thermodynamics is concerned.

A particularly simple and fruitful way of expressing the criterion for irreversible changes given by the second law of thermodynamics is to state that in the case of one single irreversible reaction, the product of affinity and reaction velocity is necessarily positive[1]:

$$A\,v > 0 \qquad (1)$$

The velocity v is the time derivative of the degree of advancement of the reaction, the affinity A is defined, for instance, as minus the partial derivative of the free energy or thermodynamic potential with respect to this degree of advancement, pressure and temperature being constant. If two independent reactions occur simultaneously in the system, the second law requires

$$A_1\,v_1 + A_2\,v_2 > 0 \qquad (2)$$

Two reactions are independent when, representing them by ordinary chemical formulas, it is impossible to derive one from the other by some rearrangement. Several reactions are independent when none of them can be derived from the others by means of a linear combination. Suppose now that, for some particular state of the system, we have $A_2 > 0$, $v_2 > 0$, $A_1 < 0$.

It follows from (2) that

$$v_1 < -\frac{A_2}{A_1}\,v_2 \qquad (3)$$

(Division by $A_1 < 0$ requires the change in the sign of the inequality). This upper limit of v_1 is positive, which shows that reaction 1 may occur in its unnatural direction. In other words, coupling of reaction 1 by reaction 2 is thermodynamically possible. The velocity of the coupled reaction must, however, remain inferior to a certain definite limit. We should add that the equality sign is also allowed in formula (3). We consider this very simple theorem as a typical piece of thermodynamic information concerning reaction rates.

Coupled or reversed reactions in biological systems have been observed and discussed by Borsook[2] and other authors. We hope that rate measurements will at some time or other be made on such systems and that our formula (3) will then be directly verified. We would also be interested in discovering a clear-cut case of coupling in some non-biological system.

A more detailed study of the thermodynamics of coupled reactions has been published elsewhere.[3]

PIERRE VAN RYSSELBERGHE
STANFORD UNIVERSITY

[1] Th. De Donder and P. Van Rysselberghe, "Thermodynamic Theory of Affinity. A Book of Principles." Stanford University Press, 1936. P. Van Rysselberghe: *Chemical Reviews*, 16: 37, 1935.

[2] H. F. Schott and H. Borsook, SCIENCE, 77: 589, 1933; H. Borsook, *Ergebnisse d. Enzymforschung*, 4: 1, 1935, etc.

[3] P. Van Rysselberghe, Académie royale de Belgique, Bulletins de la Classe des Sciences, December, 1936.

MAGNIFICATION OF TIME AS A RESEARCH TECHNIQUE IN THE STUDY OF BEHAVIOR

THE magnification or condensation of *space* by means of a microscope or telescope and the magnification or condensation of *energy* through thousands of mechanical and electrical devices are established scientific methods which we take for granted. It seems peculiar that the magnification or condensation of *time* has so infrequently entered into scientific concept and methodology, particularly since the means of such time magnification or condensation have been at hand and used for twenty or thirty years. We refer to ultra-rapid and infra-slow motion picture photography.

Ultra-rapid motion picture photography usually refers to pictures taken at approximately 64 exposures per second and subsequently projected at 16 to 20 exposures per second, thus affording a time magnification of four. Until recently comparatively little work has been done above this speed. The problems of film sensitivity, shutter speed, intermittent forward motion of film and of high illumination have all been obstacles. With the perfection of the revolving prism camera by Day, of stroboscopic illumination and synchronized camera by Edgerton, and of the commercial production of supersensitive film, we now have facilities for the magnification of time to effects which are higher than 200 "diameters."

As an example of the application of these new time magnification methods we have been making a study of the behavior responses of adults, infants, children and the higher primates to the sound of a pistol shot. To the naked eye this response is a confused mass of behavior. Using cameras running at a speed of 64 exposures per second it has been possible to demonstrate a clear, unmistakable, immediate, stable, reflex pattern in all the groups we have studied. This primary pattern is very rapid and is usually complete in one-half second or less. The primary response is then followed by a secondary response which is variable, differs among individuals and partakes of the nature of a socialized, conventional, learned response

as opposed to the reflex nature of the primary response.

This method has made it possible to sort out the various occurrences in the seemingly very rapid responses following the gunshot. In the infant it is possible to differentiate between the primary startle pattern and the Moro reflex. In the adult we can separate the primary reflex response from the "voluntary jumping," etc. In patients showing Parkinsonian tremor the ultra-rapid photography shows a very brief cessation of the tremor after the gunshot, during which period the elements of the startle pattern appear, followed by resumption of the tremor.

While much can be done, as we have shown, with the relatively small magnification provided by a camera speed of 64 exposures per second, there is much more to be obtained at higher camera speeds. We have now begun to work with cameras capable of running as fast as 3,000 exposures per second. At present, we have results at speeds of 700 and 1,500 exposures per second. We have applied these speeds to the problem of voluntary facilitation of the reflex startle response. With the naked eye, it is impossible to separate the original response from the voluntary facilitation. At both 700 and 1,500 exposures per second, the two can be clearly separated. The primary startle pattern appears first; there is an appreciable interval; and then the "facilitation" appears as a separate response. The uses of this technique in revealing the interrelations of voluntary and involuntary response are evident. A feature of these special cameras is a timing dial included in the photographic field which may be read directly to 0.002 seconds.

The magnification of time in this fashion raises interesting perceptual problems. The dimension of time is an important determinant of the "form quality" or "gestalt" of any experience. The distortion of this one dimension may be sufficient to change the quality of the perceptual pattern. Thus, the facial elements of the startle pattern at normal speed, four times slower than normal, and fifty times slower than normal, are three qualitatively different expressions, their identity evident only if one knows the background of conditions under which the pictures were taken. The first is a "jerk," the second resembles a "hiccup," and the third a stretchy yawn. All three involve the same response with only the speed of presentation changed. Thus, the technique of temporal magnification offers a new approach to the study of time as a factor in perceptual organization.

CARNEY LANDIS
N. Y. PSYCHIATRIC INSTITUTE
W. A. HUNT
CONNECTICUT COLLEGE

CELL INCLUSIONS IN AZOTOBACTER CHROOCOCCUM BEJ.

IN a recent issue of this journal[1] I. M. Lewis, discussing the work of Jones, Löhnis and Smith, Mencl, Prazmowski and of Schmidt on the nature of the stainable granules in the cells of *Azotobacter chroococcum,* writes: "There is no indication that any of the other workers performed microchemical or solubility tests to determine whether the stainable bodies are living entities of the cell or lifeless cell inclusions which function as reserve food." He further states that his own investigations showed these to be composed of volutin.

Solely in the interest of truth and as a corroboration of the results reported by Lewis, it may be of interest here to mention a publication of the present author[2] in which, after a long series of microchemical and solubility studies, the writer concludes that "the granulations take the basic dyes and are constituted neither of fats nor glycogen, starch nor chromatine. They seem to be of a metachromatic nature." . . . and that "there is no doubt that metachromatic or, as Meyer terms them, volutine granules were found."

The reserve nature of these bodies was further demonstrated by the preesnt writer[3] by a study of their autophagy.

AUGUSTO BONAZZI
MINISTERIO DE AGRICULTURA Y CRÍA
CARACAS, VENEZUELA

SCIENTIFIC BOOKS

STATISTICAL MECHANICS

Statistical Mechanics. By R. H. FOWLER. 864 pp. Cambridge: at the University Press. New York: The Macmillan Company. 1937. $14.00.

THE first edition of this monumental work, which appeared in 1929 and which we reviewed in this journal,[1] is already a classic in the literature of theoretical physics. So it will suffice to describe the respects in which the second edition differs from the first, both in the presentation of general principles and in the applications to particular problems. The increase in size is immediately apparent. We have always thought the author must have been almost a superman to write a volume as comprehensive as the first edition on such difficult subject-matter. Now, however, the number of pages has grown from 570 to 864, and of numbered equations from 1,607 to 2,344!

1 J. H. Van Vleck, SCIENCE, 70: 41, 1929.

1 SCIENCE, n. s., 85: 16, 1937.
2 *Jour. Agr. Res.*, 4: 225–239, 1915.
3 *Jour. Bacter.*, 6: 331–359, 1921.

As regards theoretical principles, the general method, based on contour integration and steepest descents, is the same as before, the main difference being that quantum statistics are presented from the very first, whereas until the last chapter the earlier edition used the quantal adaptation of Boltzmann statistics. For many problems, it is immaterial which version is used, but the new form is necessary, for instance, in the discussion of conducting metals, where the exclusion principle plays such an important rôle, or of chemical constants, which may involve the enumeration of nuclear spins.

In the applications, the subject-matter which is treated is distinctly more comprehensive than in the first edition. The electric and especially the magnetic susceptibilities of solids are now discussed in considerable detail, in the author's usual terse and accurate style. The reviewer has detected only one error, *viz.*, the incorrect statement on p. 480 that the apparent number of electrons in nickel is lower above the Curie point than at saturation. There is a very illuminating discussion of the conditions under which the local field is E or is instead $E + 4\pi P/3$. However, it should have been more succinctly emphasized that in polar media the statistical fluctuations may limit the rigor and applicability of the local field method. Almost a hundred new pages have been inserted on the electron theory of metals, thermionics and metallic conduction, including the rather spectacular recent work on "energy bands" and on the influence of impurities in semiconductors. An interesting section is added at the very end of the book on the timely subject of the production of extremely low temperatures by the magnetic method. The presentation of the applications covered in the earlier edition, notably astrophysical problems and the equations of state of gases and solids, has been thoroughly modernized. One usually thinks of the most striking developments of the last decade in extra-nuclear physics as in theory rather than experiment, but actually a very high percentage of the relevant experimental measurements quoted in the volume are subsequent to the first edition. On the whole, the documentation of the literature is quite complete, although occasional oversights may be noted, *e.g.*, Roebuck's determination of the second virial coefficient of helium by the porous plug experiment, as calculated by Whitelaw in *Physica*. The rapid tempo at which the material treated in the volume has been, and still is, developing both on the theoretical and experimental sides shows that even the portion of physics which is not concerned with either cosmic rays or nuclear disintegration is far from being a dead subject!

J. H. VAN VLECK

METEOROLOGY

Manual of Meteorology, Volume II, second edition. By SIR NAPIER SHAW, xlviii + 472 pp. 1936. Cambridge: at the University Press. New York: The Macmillan Company, $10.00.

THE first edition of the second volume of Shaw's great four-tome manual—the volume of facts without explanations—is far too valuable to discard, but this second edition contains so much additional material that no one who tries to keep well informed about the circulation of the atmosphere, normal, seasonal and transitory, can afford to be without it.

The book begins with discussions of a number of technical terms, so clear and detailed as to merit reading and rereading by physicists as well as meteorologists. This is followed by an 8-page discussion of units and measurement that gives much valuable and even some surprising information.

This finishes the Roman-numbered pages, a valuable treatise apart even from the rest of the volume. The first six chapters of the book proper (there are ten in all) cover, in order, solar and terrestrial radiation; distribution of land, ocean, ice, volcanoes, earthquakes, thunderstorms, magnetic lines, etc.; composition of the atmosphere; temperature of the surface air the world over and through the seasons; clouds and rainfall; pressure and winds. Much of this information is given in scores of full-page hemispherical charts.

Chapter 7, which lists a great number of reputed weather cycles and correlations, must have cost the author more labor to compile than any other in the entire manual. It deals with prodigious labors that essentially came to naught, for cycle study long has been, as presumably it long will continue to be, the fatal candle for the meteorological moth.

In Chapter 8 are discussed the several transitory variations of pressure, especially the tropical cyclone, the tornado, waterspouts and line squalls. The first portion of Chapter 9 consists of accounts of the earlier ideas of the structure of the mid-latitude cyclone, and the rest to an explanation of our present notions of this structure based on air-mass analysis. Chapter 10, the last in the book, and bringing it up to date, is a meteorological potpourri consisting of a number of interesting discussions of rather disconnected matters—the solar constant, duration of snow cover, arctic ice, the upper atmosphere, dust storms, weather in Greenland, etc. This is followed by an extensive and conveniently arranged bibliography, and that in turn by a 20-page, double-column index.

Here and there throughout the volume are delightful passages that "sample" pretty nearly pure Shaw, rather than mere meteorology, but they are none the less informative for all that and twice as interesting.

W. J. HUMPHREYS

CULTURE METHODS FOR INVERTEBRATES

Culture Methods for Invertebrate Animals, a Compendium prepared Cooperatively by American Zoologists under the Direction of a Committee from Section F of the American Association for the Advancement of Science. PAUL S. GALTSOFF, FRANK E. LUTZ, PAUL S. WELCH and JAMES G. NEEDHAM, *chairman*. Ithaca, xxxi + 590. 1937. Comstock Pub. Co., $2.00.

"THIS book has been prepared as an aid to studies that require living animals in continuous supply." It was compiled by Miss Mary E. Davis, under the direction of the four members of the committee. One hundred and eighty-six collaborators have contributed one or more articles, and information from other sources has been reprinted. The book begins with three general introductory chapters in which certain common methods of collecting and caring for terrestrial and aquatic animals are discussed. The remainder is taken up with articles which are primarily concerned with cultural methods, but often digress into other fields. For example, the brief but excellent section by R. K. Nabours gives stimulating suggestions as to favorable lines of research on grouse locusts; Dr. Libbie H. Hyman not only tells how to keep planarians under laboratory conditions, but also points out how different types may be utilized for various purposes; and J. Speed Rogers gives detailed directions for rearing various types of crane-flies from diverse habitats. Articles are arranged systematically under their respective phyla, beginning with Protozoa and ending with Ascidacea. As would be expected, considerable space is given to protozoans and arthropods.

This work will be useful for those who maintain animals for experimental work or teaching. It covers a wide range and is well organized, with cross references and a complete index. The committee which prepared it is to be congratulated on its good work. Many of the advances in scientific discovery have been made possible by the availability of dependable material for observation and experiment. The publication of culture methods by which animals may be maintained for such procedures is a valuable service.

A. S. PEARSE

SOCIETIES AND MEETINGS

THE TORONTO MEETING OF THE AMERICAN ASSOCIATION OF ANATOMISTS

A VERY successful session of the American Association of Anatomists was held in the brisk atmosphere of Toronto from March 25 to 27. The registered attendance was 303, of whom 281 were from out of town.

The meeting opened with three papers on the lung, treating respectively the factors initiating respiration in the embryo, the mechanical expansion of alveoli by the inhalation of amniotic fluid, and the nature of the ultimate alveolar lining. Nine other papers were read that morning, chosen from the several fields into which anatomy is now subdivided. Thereafter it was generally necessary to hold from three to six simultaneous meetings to cover the lengthy program of 150 papers and 58 demonstrations. At the evening smoker, Dr. G. L. Streeter described, with lantern slides, the International Congress of Anatomists at Milan last September. Eight Americans had attended, and all presented papers. President Livini was pictured in Fascist attire, addressing the congress on the glories of Italian anatomy. Everywhere one heard the Giovanezza and saw the marching squadrons. The congress included a memorable visit to the Carthusian monastery and the ancient university of Pavia.

On the second day in Toronto, multiple sessions continued. By invitation of the president, six members of the association undertook the organization of round-table conferences, dealing with special subjects as follows: "Factors in Sperm Production," P. E. Smith, Columbia University; "Structure of the Teeth," T. Wingate Todd, Western Reserve University; "Embryonic Heart," Bradley M. Patten, University of Michigan; "Present-day Trends of Investigation in the Field of Gross Anatomy," R. J. Terry, Washington University; "The Structure of Neurons and Its Functional Significance," D. M. Rioch, Harvard Medical School; "Blood Capillaries," E. V. Cowdry, Washington University. Attendance at these round-table conferences numbered from 50 to 150. All of them gave rise to a general discussion.

Three of the round tables, and three general sessions besides, occupied the second morning. The afternoon was devoted to motion-picture and other demonstrations. Then came the annual dinner of the association, in the Ball Room of the Royal York Hotel, attended by 199 persons. Led to their places by two bagpipers in Highland dress, who continued to play at intervals, the anatomists dined heartily on roast beef and Yorkshire pudding. A message from His Excellency, the Governor-General of Canada, was read as follows:

> It is with great pleasure that I welcome to Canada the American Association of Anatomists. Your coming is a further example of the fact that science knows no political frontiers. You have my best wishes for the success of your deliberations.
>
> TWEEDSMUIR

To which this reply was sent:

The American Association of Anatomists assembled at Toronto is gratified to receive Your Lordship's stimulating message. We would assure Your Excellency that Canadian and other American anatomists form what we call a syncytium.

THE SECRETARY

The Hon. and Rev. Henry John Cody, president of the University of Toronto, led the after-dinner speaking with a most cordial address of welcome, in which he described briefly the organization and character of the University of Toronto, with its 8,000 students. President Cody also called attention to the number of Canadian medical scientists, and particularly to the anatomists trained in Canada who have influenced anatomical work in the United States, mentioning especially Professors Osler and McCrae, Addison, Barker, Bensley, Chambers, Cowdry, Harvey, Macklin and McMurrich.

Dr. J. P. McMurrich, professor emeritus of anatomy in the University of Toronto, sketched biographically two pioneer contributors to anatomy in Canada: Michel Sarrazin (1659–1735), who first described the comparative anatomy of Canadian mammals in communications to the Académie Royale in Paris, and James Douglas (1800–1886), a prominent early teacher of human anatomy and the 'grand old man' of Quebec.

The president of the association, Professor F. T. Lewis, of Harvard University, then delivered the annual presidential address entitled "The Fundamentals of Cell Shape."[1] In advance of publication, he was permitted to announce the finding of Dr. J. W. Marvin, of Columbia University, that compressed lead shot of one size have an average of 14 facets—not 12—so that an accepted distinction between solid and liquid bodies in this respect disappears. With solids, such as a mass of peas, a primary contact with 12 neighbors may be expected, but upon expansion to fill completely all interstices, an average of 14 facets will be established, as indeed might be expected from *a priori* considerations. The lecturer indulged the hope that sometime there may be a symposium, with lively discussion, on the neglected problems of cell shape and statics, "for there are indications" which he seemed to see "of a ripple of interest in that direction."

The final day included five morning programs, valuable throughout. Special mention may be made of the superb moving pictures of capillaries in the frog, reacting to the external stimulus of a needle point by the thickening of individual endothelial cells and the local adhesion of a pair of passing red corpuscles (Zweifach and Chambers, New York University).

Four afternoon papers of greater length preceded adjournment. Professor Boyden, of the University of Minnesota, primarily interested in Talmudic anatomy as a commentary on gall-bladder anomalies, explained the nature of this lore in a comprehensive historical survey. Professor Kappers, of the Institute for Brain Research, Amsterdam, showed in detail the comparative anatomy of the hypothalamic autonomic centers, and Professor Ranson dealt with their functional significance. Finally Professor Bensley presented his penetrating micro-chemical studies of mitochondria, dealing with the distribution of lipids in protoplasm and their relation to its constitution.

Professor Grant, of the University of Toronto, and his associates on the local committee, in cooperation with Professor Corner, of the University of Rochester, the able and experienced secretary of the association, had anticipated every need of such a convention. The first Canadian session of the Anatomists was rewardingly alert.

CORRESPONDENT

SPECIAL ARTICLES

CORTICAL REPRESENTATION OF TACTILE SENSIBILITY AS INDICATED BY CORTICAL POTENTIALS[1]

THE observations reported below were obtained in the course of experiments directed toward a functional analysis of the somesthetic area of the cerebral cortex. It was thought that a study of the slow components of potentials which may be picked up by widely separated electrodes and which presumably result from the summed activity of cortical elements might be of value. First in cats and later in monkeys, it was found that the application of discrete tactile stimuli to a given cutaneous area produces in the cortex of the anesthetized animal well-localized surface positive waves. The potentials are of such magnitude, show such regularity over periods of time and are so decisive in all their characteristics that we have been able to employ them in mapping a cortical representation of the tactile sensibility of the body surface.

The most essential requirements for observing and recording these potentials are: (1) anesthesia of sufficient depth to reduce the Berger waves to minimal frequency and size;[2] (2) the use of mechanically dis-

[1] For summary, see SCIENCE, April 2, 1937, Supplement, p. 10.

[1] From the Department of Physiology, Johns Hopkins University School of Medicine.

[2] It has previously been shown that surface positive activity occurs in the deeply anesthetized cat's cortex

crete stimuli which are brief in duraton, low in frequency and near the human threshold in intensity; (3) properly spaced thread electrodes. A cathode ray oscillograph is used for observing and recording the responses.

Stimulation is most effectively applied to hair-covered areas by a small camel's hair brush, to bare regions by a von Frey hair. These objects are mounted on a light lever of laminated wood which is rigidly attached to the moving armature of an electromagnetic device. The coils of the magnet are energized by a pulse 2 msec. in duration. This produces a regular, quick, to-and-fro movement which, at the end of the lever, amounts to a displacement of approximately 0.5 mm. The electrical pulse generator is a thyratron vacuum tube device possessing widely adjustable parameters and triggered by an independent circuit which also controls the x-axis unit of the cathode ray tube. Thus the pulse which activates the stimulator occurs at a given and adjustable point on the x-axis line. This part of the procedure makes it possible, provided the C.N.S. behaves with sufficient uniformity, to carry out observations with a facility comparable to that enjoyed in studies of the axon potentials of isolated nerve trunks. Experiments on 14 monkeys and 10 cats have shown this to be the case. Even when such disturbances as Berger waves interfere with the regularity and simplicity of the record, the above procedure usually enables one rapidly to determine the presence or absence of a correlated response.

The animals are anesthetized with pentobarbital sodium, chloralosan or dial. The skull is removed so as to expose the greater portion of the surfaces of one or both cortices, dural flaps are turned away and a Cellophane tracing made of such landmarks as sulci and prominent pial vessels. The head of the animal is then immobilized in a Horsley-Clarke instrument constructed to carry two electrodes. This arrangement permits rapid and precise placing of the leads on the pial surface. The electrodes consist of No. 50 cotton thread drawn through sections of steel tubing and kept wet with Ringer's solution. One electrode is placed at a given point on the somesthetic area, the other on an indifferent region, *e.g.*, occipital, temporal or pre-frontal cortex. Many observations have shown us that, provided the two leads are separated by a distance of one cm or more, the position of the "indifferent" electrode has no significant effect on potentials attributable to activity under the "different" electrode. If the animal's blood temperature is maintained at a normal level, frequent wetting of the pial surface with Ringer's is unnecessary and may even cause deterioration. With repeated doses of anesthetic observations may be continued for many hours. During periods of twenty-four hours the potentials obtained in response to tactile stimulation do not progressively undergo significant reduction or changes in character. In the course of most experiments they occasionally disappear for periods of from one to five minutes, but reappear and soon regain their previous size and form.

By using the methods and principles described above we have observed that a well-localized surface positive wave regularly follows each restricted tactile stimulus. Although stimulation of a specific peripheral locus elicits positive potentials detectable over a cortical area of several square millimeters, one or more discrete spots of maximal potential are always found. The site or sites of these can be determined only by exploring the area in steps of a fraction of a millimeter. The size of a cortical area varies with the part of the periphery stimulated. In the monkey, for example, stimulation of a few hairs on the anterior aspect of the lower leg gives rise to a potential change which is restricted to a small area on the contralateral postcentral gyrus. The maximally active spot is about the size of the effective area of the electrode. The potential drops to 25 per cent. of maximum when the "different" lead is moved 0.5 mm medially or rostrally from this point, to 5 to 10 per cent. when the displacement is 1.0 mm in either of these directions. Laterally and caudally the potential decreases somewhat less abruptly. On the other hand, von Frey hair stimulation of the tip of the great toe produces potential changes within a different but larger cortical area. In this case there are two and sometimes three spots of major potential situated 1 to 5 mm from one another. One of these, usually that nearest the central sulcus, shows the shortest latency and the steepest wave front. The others have a definitely longer latency, which appears as a 2 to 5 msec. shift in the entire wave. The fact that in any cortical area the potentials decrease much more precipitously when the electrode is moved in one direction than in another indicates the part played by purely physical spread. In general our experience suggests that within any area potentials greater than 10 per cent. of the maximal are physiologically significant if they occur at distances greater than 1 mm from the maximal point. Electrotonic spread is not so easily estimated, but hardly accounts for the magnitude and behavior of certain of the propagated waves.

The amplitude of a maximal potential may be as great as 1 millivolt, but it usually lies between 100 and 300 microvolts. The rising phase occupies from 3 to 6 msec., the falling phase from 10 to 80 msec.

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when the sciatic nerve trunk is tetanized by direct electrical stimulation. See A. J. Derbyshire, B. Rempel, A. Forbes and E. F. Lambert, *Am. Jour. Physiol.*, 116: 577, 1936.

Under given conditions these values are quite constant. In the monkey the latencies, in milliseconds, average 15 to 20 for toes, 8 to 11 for fingers and 5 to 9 for face; in the cat the values are, approximately, 11 msec. for hindfoot, 8 for forepaw. The values may fluctuate as much as 20 per cent., but are usually constant within 5 per cent. We usually employ a stimulation frequency of one a second. The response progressively decreases in magnitude as the frequency is increased and it disappears at rates of from 12 to 15 a second. This effect is probably due to the same factors which produce the masking phenomenon described below.

A given cortical spot may yield potentials of approximately equal sizes when a discrete tactile stimulus is applied successively to different points on a restricted peripheral area. Thus brush stimulation of a few hairs within an area on the leg one inch wide and two inches long evokes potentials from a specific spot. Of great interest is the fact that these responses are attenuated or obliterated (masked) if another camel's hair brush is applied with a continuous motion anywhere else within that particular skin area. If the secondary stimulation is applied beyond the boundaries of an area represented at the cortical spot it has no masking effect.

Application of Dusser de Barenne's method of thermocoagulation[3] indicates that at least the outer layers of the cortex are not essentially concerned in the elaboration of these potentials. It is possible that only the terminations of thalamo-cortical neurons are involved, but the magnitude of the potentials, the characteristics of the spreading (*cf.* Adrian[4]) and other aspects of the responses speak against such a conclusion.

A general mapping of the entire Rolandic region and the corresponding area on the medial surface of the hemisphere can be achieved in a single experiment on a monkey by exploring with the stimulator the entire body surface each time the "different" electrode is placed on one of a series of arbitrarily selected cortical spots. Such a procedure consumes many hours, but it gives a good outline of a stable arrangement, the total representation which is revealed by these potentials. It uncovers a more detailed picture than any heretofore presented. Under the conditions of our experiments the representation appears to be confined to areas 3, 1 and 2. Up the postcentral gyrus to the hemispheral rim and then down the medial surface to sulcus cinguli the parts of the contralateral body surface are represented in an orderly sequence which roughly corresponds to that of the motor points on the precentral gyrus. Evidence has been found that in the case of the leg this sequence reflects the metameric origin of the dermatomes. No maximal potentials in response to tactile stimuli are found precentrally. Only the face has shown a definite bilateral representation.

This study, based on receptor stimulation and correlated electrical response, has disclosed a cortical representation of tactile sensibility which is definitely stable. We conclude that whatever functional variations may characterize the total cortical response to a tactile stimulus they are based on a highly stable anatomical substratum which is functionally demonstrable.

WADE H. MARSHALL,
Fellow, National Research Council
CLINTON N. WOOLSEY
PHILIP BARD

[3] J. G. Dusser de Barenne and H. M. Zimmerman, *Arch. Neurol. and Psychiat.*, 33: 122, 1935.

[4] E. D. Adrian, *Jour. Physiol.*, 88: 127, 1936.

QUANTITY ULTRACENTRIFUGATION WITH INTENSE FIELDS

THE air-turbine drive[1] makes it possible to ultracentrifuge[2] large volumes of liquid as well as to carry out the analytical procedures developed by Svedberg[3] and his coworkers. This quantity ultracentrifugation has already been used for several purposes—to concentrate the activity of yellow fever virus[4] and the pneumococcic antibodies[5] in immune horse serum and to crystallize[6] tobacco mosaic virus protein[7] directly from the juice of infected plants. Taken in conjunction with ultracentrifugal analyses it has been employed to isolate the unstable virus proteins responsible for several plant diseases[8] and to obtain in a pure state a similar substance,[9] which carries the virus activity causing infectious papillomatosis in rabbits. It is now being used routinely for the preparation of virus proteins in quantities sufficient for a detailed study of their biological, chemical and physical properties. Such ultracentrifugal preparation of proteins too unstable or present in too small amounts to be ex-

[1] E. Henriot and E. Huguenard, *Compt. rend.*, 180: 1389, 1925; *Jour. phys. radium*, 8: 443, 1927; J. W. Beams, *Rev. Sci. Instr.*, 1: 667, 1930; J. W. Beams and E. G. Pickels, *ibid.*, 6: 299, 1935.

[2] J. Biscoe, E. G. Pickels and R. W. G. Wyckoff, *Jour. Exp. Med.*, 64: 39, 1936; J. H. Bauer and E. G. Pickels, *ibid.*, 64: 503, 1936; R. W. G. Wyckoff and J. B. Lagsdin, *Rev. Sci. Instr.*, 8: 74, 1937.

[3] See T. Svedberg, *Naturwiss.*, 22: 225, 1934, for bibliography.

[4] J. H. Bauer and E. G. Pickels, *op. cit.*

[5] R. W. G. Wyckoff, SCIENCE, 84: 291, 1936.

[6] R. W. G. Wyckoff and R. B. Corey, SCIENCE, 84: 513, 1936.

[7] See W. M. Stanley, *Am. Jour. Botany*, 24: 59, 1937, for bibliography.

[8] W. M. Stanley and R. W. G. Wyckoff, SCIENCE, 85: 181, 1937.

[9] J. W. Beard and R. W. G. Wyckoff, SCIENCE, 85: 201, 1937.

tracted by the usual chemical procedures has suggested that very probably it could isolate other biologically active substances in an unaltered condition.

Virus proteins have proved to be of exceptionally high molecular weight, and the centrifugal fields most advantageous for sedimenting and purifying them do not exceed about 50,000 times gravity. Antibodies, enzymes, protein-linked hormones and the like are smaller and therefore need higher fields for their concentration.

Using suitably shaped heads of light metal alloys we have centrifuged volumes in excess of 100 cc for as long a period as desired in fields several times those employed in the virus work. If the quantity head is made of one of the commercially available magnesium-rich alloys, the maximum field that can safely be used has been between 200,000 g and 250,000 g. Duralumin heads of the same size will run well between 250,000 g and 300,000 g; one has been operated for several hours somewhat above 350,000 g, though this is so near the bursting field that routine operation probably is impractical. In the present design of head a field of 300,000 g is attained at 60,000 r.p.m.

These fields will concentrate most proteins from aqueous or dilute salt solutions. The efficiency of concentration depends on many factors, notably the duration of the run and the viscosity, and hence the concentration and temperature, of the solution. Whether a protein sediments as a solid mass or accumulates in a liquid layer in the centrifuge tube will depend on its solubility.

In order to obtain a measure of the degree of concentration afforded by these higher fields, solutions of proteins with small sedimentation constants have been

TABLE I

CONTENTS OF LAYERS OF PROTEIN SOLUTIONS ULTRACENTRIFUGED FOR THREE HOURS

	Egg Albumin[10] $s = 3.4 \times 10^{-13}$ $M = 32,000$		Hemoglobin[11] $s = 4.4 \times 10^{-13}$ $M = 68,000$		Felton Pneumococcic Antibody[12] $s = 16 \times 10^{-13}$ cm sec^{-1} dynes^{-1} $M =$ ca 500,000	
	5×10^4g	2×10^5g	5×10^4g	2×10^5g	5×10^4g	2×10^5g
	Per cent.		Per cent.		Per cent.	
Top	0.8	0.6	0.9	< 0.1	0.1	< 0.1
Middle ..	0.9	1.4	1.1	< 0.1	1.0	< 0.1
Bottom .	1.2	4.8	1.9	6.0	3.8	6.0*
Original solution	0.85		1.0		1.9	

* Most of the antibody was present in the bottom of the tube as a solid precipitate.

[10] B. Sjogren and T. Svedberg, *Jour. Am. Chem. Soc.*, 52: 5187, 1930.

[11] T. Svedberg and J. B. Nichols, *Jour. Am. Chem. Soc.*, 49: 2920, 1927; T. Svedberg and A. Hedenius, *Biol. Bull.*, 66: 191, 1934.

[12] J. Biscoe, F. Herčik and R. W. G. Wyckoff, SCIENCE, 83: 602, 1936; M. Heidelberger, K. O. Pedersen and A. Tiselius, *Nature*, 138: 165, 1936; M. Heidelberger and K. O. Pedersen, *Jour. Exp. Med.*, 65: 393, 1937.

spun under otherwise comparable conditions at maximum fields of 50,000 g, 200,000 g and 250,000 g. The amount of protein in different layers was determined at the conclusion of the runs. Some results comparing the 50,000 g and the 200,000 g fields are recorded in Table I. It is apparent from these and similar data that molecules with $s > 15$ can be concentrated and those with $s > 40$ can be sedimented within a reasonable time by fields not greater than 50,000 g. Egg albumin is concentrated in the 200,000 g field and hemoglobin can be thrown down completely, though the time needed for such sedimentation is of the order of six hours.

No serious new mechanical difficulties are met in working at 200,000 g. The transparent containers heretofore employed have not withstood still higher fields, but as long as a liquid is not corrosive it can be placed directly in the head and successive layers pipetted off after a run.

Details of the construction of quantity heads suitable for these higher fields as well as examples of their use in protein isolation and purification will be published later.

RALPH W. G. WYCKOFF
ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, PRINCETON, N. J.

BREAKING THE REST PERIOD OF THE STRAWBERRY BY LONG DAYS AT HIGH TEMPERATURES

EXPERIMENTS reported herewith indicate that long days at high temperatures may be fully effective in breaking the rest period of strawberries. The leading southern strawberry varieties when raised in the South* require little or no low-temperature rest period in winter to enable them to start into vigorous growth. In contrast, northern varieties under natural field conditions require a low-temperature rest period in winter before they start vigorous growth.

During the winter of 1935–36, 10 varieties—Missionary, Southland, Blakemore, Bellmar, Dorsett, Fairfax, Narcissa, Catskill, Howard 17 (*Premier*) and Burrill—were selected to represent the most widely different growth types. Missionary, Southland and Blakemore were included to represent the southern varieties, which grow the most vigorously in short days, and Howard 17 and Burrill represented the northern varieties, which grow slowly, if at all, under short-day conditions. The other varieties are intermediate in their growth response. The plants were exposed in the greenhouse to three photoperiods (16-hour, 14-hour and normal winter days of the latitude of Beltsville, Md., ranging from 13 to 10 hours long) at each of three temperatures (70° F., 60° F., and 55° F.). The increased daily-light periods were obtained by supplemental exposure for suitable periods

at the end of each day to 500-watt Mazda lights suspended about 24 inches above the plants. In each light and temperature test there were three plant groups, one group placed under the differential light treatments on September 1; a second group brought into the greenhouse and placed under the light treatments on November 15, after having been exposed to the normal temperatures and short days of fall (about 11 hours); and a third group brought into the greenhouse and placed under the light treatment on January 1, after having had a low-temperature rest period in an unheated house. Records were taken on March 2, after the September 1 lots had been in the greenhouse 6 months, the November 15 lots 3½ months, and the January 1 lots 2 months. Leaf areas for one plant each of Blakemore and Fairfax were averaged to indicate amount of growth attained under each treatment, as an examination of all plants of all varieties showed that these two varieties were representative except in the case of Missionary under short days. Table 1 gives the average leaf area for the plants of the two typical varieties under the different light and temperature conditions on March 2.

TABLE 1

EFFECT OF VARIOUS PHOTOPERIODS AND TEMPERATURES ON LEAF AREA OF STRAWBERRY PLANTS, BELTSVILLE, MD.

Date of starting experiment	Condition of plant at start of experiment	Average leaf area on March 2, 1936					
		Day length at 70° F.			Day length at 60° F.		
		16-hr. day	14-hr. day	Normal day	16-hr. day	14-hr. day	Normal day
		Sq. cm	Sq. cm	Sq. cm	Sq. cm	Sq. cm	Sq. cm
Sept. 1	Not resting ..	934	667	426	913	460	407
Nov. 15	Resting	1,023	991	508	531	200	274
Jan. 1	Rest broken	1,023	947	668	825	581	422

At 70° F. all varieties in all three groups developed approximately the same leaf area, both in the 16-hour- and the 14-hour-day tests (the September 1 14-hour-day plants being smaller but not significantly so). In the normal-day lot, however, the September 1 and November 15 groups were similar and were still in their rest period, while the January 1 group had developed a considerably larger leaf area, indicating that its rest period had been broken. Thus, a 70° F. exposure to photoperiods of 16 and 14 hours (1) prevented a rest period in the September 1 group and (2) broke the rest period in the November 15 group. Previous exposure to low temperatures had already broken the rest period of the January 1 group.

At 60° F. the 14-hour- and normal-day lots of the September 1 group were still in their rest period, while the 16-hour lot was growing vigorously. None of the November 15 group grew vigorously at 60° F., although the 16-hour lot made some growth. Plants in the 14-hour- and normal-day lots of the November 15 group even decreased in size from loss of leaves. Each lot of the January 1 group made good growth (the normal-day plants after two months actually being as large as the September 1 normal-day lot) after six months in the greenhouse. Thus, at 60° F. under 16-hour days, (1) plants that were not in the resting condition at the start of the experiment (*i.e.*, the September 1 lot) did not undergo a rest period; and (2) plants that were in the resting condition at the start (*i.e.*, the November 15 lot) had their rest period partially broken at 60° F. under 14-hour days; (3) plants not in the resting condition (*i.e.*, September 1 lot) went into a rest period; and (4) plants in the resting condition (*i.e.*, November 15 lot) did not have their rest period broken.

The strawberry differs from many plants in that it retains its green leaves while in the resting condition. Most fruit plants lose their leaves when entering the rest period, and as a result light has no effect on the rest period. In southern states, when there is not sufficient low temperature in winter to break the rest period of fruits such as the peach, the leaves appear slowly, and after many weeks the rest period is broken and active growth is resumed. In contrast, in this experiment the strawberry plant had green leaves through which light could have an effect, and long days at high temperatures were fully effective in breaking the rest period.

GEO. M. DARROW

BUREAU OF PLANT INDUSTRY
U. S. DEPARTMENT OF AGRICULTURE

BOOKS RECEIVED

Actualités Scientifiques et Industrielles. 328, Exposés d'Histoire et Philosophie des Sciences, 1936, III: Histoire des Origines de la Théorie Cellulaire, by MARC KLEIN. Pp. 71. *376, Biologie du Travail et Biotypologie. I: La Sélection du Personnel dans les Entreprises de Transport*, by PIERRE LÉVY. Pp. 37. 4 figures. *397, Exposés de Biologie: VI, La Coacervation les Coacervats et Leur Importance en Biologie*, by H. G. BUNGENBERG DE JONG. *Tome I, Généralités et Coacervats Complexes.* Pp. 52. 13 figures, 3 plates. *398, Tome II, Coacervats Auto-Complexes.* Pp. 64. 11 figures. *401, Biophysique Moléculaire, I, La Temperature Critique du Sérum:* P. LECOMTE DU NOÜY. *I, Viscosité et Phénomènes Optiques.* Pp. 83. 36 figures. *402, II, Phénomènes Optiques et Phénomènes Ioniques.* Pp. 187. 79 figures. *403, III, Fixation d'Ether-Tension Interfaciale et Spectre d'Absorption Ultra-Violet.* Pp. 228, 93 figures. *404, IV, Action des Lipoïdes sur les Phénomènes de la Lyse*, by BARUCH S. LEVIN. Pp. 83. Illustrated. Hermann & Cie, Éditeurs, Paris.

FISCHER, MARTIN. *Christian R. Holmes, Man and Physician.* Pp. 233. Illustrated. Thomas.

HOLMES, ERIC. *The Metabolism of Living Tissues.* Pp. x + 235. Macmillan, Cambridge University Press. $2.25.

RUSK, ROGERS D. *Atoms, Men and Stars; A Survey of the Latest Developments of Physical Science and Their Relation to Life.* Pp. xxviii + 289 + ix. Knopf. $3.00.

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BOTANIC GARDENS IN SCIENCE AND EDUCATION[1]

By C. STUART GAGER

DIRECTOR, BROOKLYN BOTANIC GARDEN

ONE could hardly expect to find an intellectual climate more salubrious for discussing things botanical and horticultural than that of the environs of Swarthmore. It is located in the only state of our union that has any reference to plant life in its name.

Whether it was something in the name, "Penn's Woods," or something in the blood of the early settlers—or a combination of both—I am unable to say, but the fact remains that botanic gardens and arboretums just naturally came into being in this region like mushrooms after a rain, springing up here and there over a period of some 200 years.

The Rosicrucians apparently came first with their medicinal plant garden on the banks of the Wissahickon in the very first years of the eighteenth century. Then came, in succession, the botanic garden of Christopher Witt in Germantown, in 1708; Bartram's famous garden in 1728; Humphrey Marshall's garden at West Bradford in 1773; John Evans's arboretum, near Bryn Mawr, in 1828; the Painter Arboretum, established by Minshall Painter and his brother about 1835; William Darlington's arboretum, laid out as part of the public park at Westchester, about 1850; the old botanic garden of the University of Pennsylvania, initiated by Professor McFarland in 1892; and then the Arthur Hoyt Scott Foundation here at Swarthmore, beginning in 1928 and antedating by four years the Morris Arboretum in Philadelphia, which is the youngest offspring of botanical interest in this region.

[1] Founder's Day address, delivered at Swarthmore College on October 31, 1936.

One feels almost out of breath by the mere recital of names and dates. I know of no other region of similar size in America that can boast of so many botanic gardens. In a very real sense Swarthmore is at the American center of distribution of botanic gardens, for the idea spread from this region to New York and elsewhere throughout the nation.

But, for some reason or other it did not spread very fast. Almost every city of any considerable size in Europe has its botanic garden and has had for a generation or more. The same is true of the Old World universities—Pisa, Padua, Paris, Oxford, Cambridge, Berlin, Munich, Amsterdam, Copenhagen and others.

In America municipal botanic gardens are rare, and as late as 50 years ago only a few American universities had botanic gardens. Only about fifty American cities out of some 980, having a population of 10,000 or more, can now boast of a botanic garden, and 22 of these were established during the past 25 years—most of these 22 during the past ten years.

It is significant to see these institutions coming into being at the rate of nearly one a year during the period of a world war and a world-wide economic depression. Probably no other kind of scientific or educational institution has multiplied so rapidly during the past quarter century. This is only one of numerous evidences of an expanding and deepening interest in botanical and horticultural science during this period. The establishment of the Arthur Hoyt Scott Foundation places Swarthmore College in the vanguard of educational progress in this important field of knowledge.

The promotion of gardens and of gardening has by no means been limited to gardeners. It has always been a concern of great philosophers and great rulers. Pliny tells us, in his "Natural History," that Epicurus, "that connoisseur in the enjoyments of a life of ease," was the first to lay out a garden in Athens, where he met his students and did his teaching; "up to his time," says Pliny, "it had never been thought of to dwell in the country in the middle of the town." When Epicurus died (in 270 B.C.), he left his garden, known as the "Gardens of Epicurus" (Κῆποι Επικούρου), and some funds to two trustees, who devoted the garden to the school of Epicurus.

Charlemagne established gardens by royal edict, and even prescribed what plants were to be grown in them. It is of profound significance that a man who had such tremendous administrative responsibilities as did Charlemagne should consider that the establishment of gardens merited his personal attention.

Cosmo de Medici (1555) and King Henry IV of France (Montpellier, late sixteenth century) were also among the great rulers who established gardens. One of the great botanic gardens of the world—that at Kew, near London, dates from the appointment of William Aiton to organize a physic (or medicinal plant) garden for the Princess Augusta, Dowager Princess of Wales. These gardens remained a private possession of the crown until as late as 1840, when "Kew" was made a public garden.

Perhaps the outstanding instance of the founding of a botanic garden by a great scholar is the garden established at Athens by Aristotle, who is said to have endowed it from his wealth and made his pupil, Theophrastus, the "director" of it.

History tells us that Theophrastus conducted this garden for some 50 years. When he died, in 285 B.C., he left it to a group of his intimate friends—perhaps a kind of board of trustees. It appears to have functioned as a center of botanical study for about three generations. Of special interest, at this time and place, is the fact that the Athens botanic garden quite probably partook largely of the nature of an arboretum. This is suggested, in part, by the fact that of Theophrastus's book, "Inquiry into Plants,"[2] five books out of nine and 426 pages out of 476 are devoted to trees and shrubs. He describes 183 kinds—an unusually large number for that day.

By the generosity of another wealthy friend, Theophrastus was enabled to improve the Athens botanic garden on an extensive scale. The name of this early patron and benefactor of botany, the spiritual ancestor of Mrs. Arthur Hoyt Scott and Mrs. Owen Moore, was Demetrius Phalereus; it should be remembered and perpetuated, as theirs will be, wherever botanic gardens and arboretums are established and maintained.

Theophrastus, as we all know, was not only a botanist but a philosopher—an early "encyclopedist" of learning. There have been preserved the titles of more than 225 books which he wrote; and besides this productive scholarship, he directed a school of some 2,000 students in which he also taught.

With all these duties how could Theophrastus acquire the vast knowledge of botany which is revealed to us in his two-volume treatise of nine books? For there were in classic Greece, as here and now, only 24 hours in a day, and Theophrastus, like modern professors, had to devote some hours each day to eating and sleeping.

Theophrastus traveled little, yet he gives accurate information about the wild and cultivated plants of Greece and other countries. This was largely made possible by the existence of the Athens botanic garden, where Theophrastus had his home, took walks and studied and thought. It was his first-hand observations in this garden that enabled Theophrastus to lift the study of plants out of the limbo of myths and

[2] English translation by Sir Arthur Hort, London, 1916.

fables, which cluttered up the writings of his predecessors.

Moreover, the books he wrote on plants are the only definite source of information as to what trees were known to the nations of antiquity prior to the Greeks.

We have in this fascinating story, of which the students of the old classical curriculum of American colleges appear to have been generally indifferent, a "random sample" of the contribution of botanic gardens, from that day to this, to the advancement of science and education.

It was the *greatest* intellects of the *greatest* civilization the world has ever known that considered the study of plants important and laid the foundations of botanical science, to the immeasurable advantage of succeeding generations. The Arthur Hoyt Scott Foundation has not only made possible here a future development along modern trends, but has placed Swarthmore College, in a new way, in the line of descent from one of the glories of ancient Greece.

This gradual penetration of the botanic garden idea from Greece and Italy up through France, Germany and England to Sweden is an interesting special case of the general principle that while humanity, throughout European history, has migrated from north to south, culture has migrated in the opposite direction.[8] It is encouraging and reassuring, in this connection, to note that learning and culture tend to diffuse themselves among the people; they have had a vitality and a momentum that have helped to carry them over a wider geographical range than the reach of physical migration of the human race. If this diffusion of learning and culture should continue, we might, in time, become really civilized. Who can tell!

A recent writer has compared 300 years in the life of a university to 25 years in the life of a man. On that basis here is Swarthmore College in "manhood's prime vigor," with its roots and its branches and its background in a soil and air and tradition of botanical science. What a logical event in its history, therefore, was the establishment of the Arthur Hoyt Scott Foundation, as stated by Mr. Wister in his first Report, "for the encouragement of horticulture in its broadest sense." Should not every educational institution whose primary aim is to promote knowledge and culture recognize in its curriculum, as one of the new humanities, the study of that science whose field is the fundamental art of civilization?

I speak of the natural sciences as "new humanities" because, if they are rightly taught, they not only keep us abreast of the most recent advances of knowledge and the method of knowledge, but they carry us back to the fountain head of modern learning as surely as did the study of Homer and Aristotle and Virgil and Livy.

Much time was given in the old classical curriculum to Aristotle, and yet how rarely was any time devoted to his scientific writings and how few realized that his scientific work had meaning for moderns. It is he, said Osler, who "speaks for the first time the language of modern science, and indeed he seems to have been first and formost a biologist . . . the founder of modern biology."

The tragedy of the shelving of the classical curriculum has not been the elimination of a general knowledge of the Greek language, great as that loss may be; it is the severing of our vital connection with the great thinkers of classic Greece while advancing the sciences *they* found by the method in which *they* were the pioneers. From the standpoint of scholarship and culture, it is almost like trying to turn on the electric light when the wires from the dynamo are cut.

I am not intending to read a belated obituary of the classical curriculum, in which I am a firm believer (for some!), nor to pronounce a panegyric on the ancient Greeks, but to point out how close we have come to overlooking one of the great cultural and liberalizing advantages to be derived from botanical science when studied and taught in historical perspective.

A few moments ago I referred to the fact that Epicurus established his "Gardens" in Athens as an *educational center*. Herein lies a fundamental distinction between a botanic garden or arboretum and a park. A public park is intended to serve hygienic, esthetic and recreational ends. So may a botanic garden. No one ever thinks of a public park as an educational center; but that is precisely what a botanic garden or arboretum essentially is. It is, in effect, an outdoors museum of plant life, about which (as in the case of a modern museum) is organized a program for the advancement and diffusion of knowledge.

To illustrate briefly: In planting a park the main consideration is beauty. No attention whatever need be paid to the botanical affinities of the trees and shrubs and herbaceous plants; the only important consideration is a beautiful landscape effect.

Beauty is equally essential in a botanic garden, just as it is essential in every aspect of life. Nothing is ever right unless it is as beautiful as we can make it. But there is one handicap in laying out a botanic garden, for some regard must always be had to botanical considerations. Our problem is to make the botanic garden or the arboretum as beautiful as we can with necessary regard for these other essentials.

Then, after the planting is done, the plants are to be labeled. This *may* be done in a park; in a botanic garden it *must* be done, for it is the primary purpose

[8] A. Wyatt Tilby, "The Distribution of European Genius. The Nineteenth Century and After," January, 1936, p. 47.

of the plantations to be educational. And then comes the organization of scientific research, growing out of, furthered by and enriching the collection of living plants; and the program of lectures, classes, field study, technical and popular publication and other educational techniques by which a botanic garden fulfills its mission and justifies the ability and effort and financial support which made it possible.

One can hardly overemphasize the importance of a study of trees. They make the beauty of our landscapes; they make possible our parks; they supply the shade and beauty of our streets. It was Loudon who declared that, next to buildings, trees and shrubs are "the most important ornaments which can be introduced into a country." The mere mention of the word "wood" suggests the innumerable ways in which trees are essential in our daily lives. Surely we ought to be interested, not only to use and enjoy them, but to know all we can about them; and whatever man is interested to know, about the world in which he lives, is worth finding out—if we can.

Of course, the ideal of the modern botanic garden and arboretum has been a gradual evolution; and yet the germ of this ideal—the essential conception—was present almost from the first. We have noted this for botanic gardens in general; the fact stands out in bold relief for arboretums.

The word arboretum, as an English word, is not quite 100 years old. It appears to have been first used by John C. Loudon, the English botanist, in his eight-volume work on "The Trees and Shrubs of Britain," published in 1838. In the body of the text he uses it freely, for example, "collecting trees from a distance . . . to assemble them in one plantation or arboretum."

The Latin dictionary, after defining *arboretum* as "a place grown with trees," gives this quotation from the Roman historian, Quadrigarius: "arboretum ignobilis verbum est, arbusta celebratius." This "ignoble" word, however, has come to designate a very noble institution.

The conception of an arboretum as a scientific center is at least as old as 1627, when the first edition of Lord Bacon's "New Atlantis" was published. The "Head of Solomon's House," describing the intellectual condition of the country, states that "The End of our Foundation is the Knowledge of Causes." Enumerating the "Preparations and Instruments" for accomplishing this end, he says:

> We have also large and various Orchards and Gardens, wherein we do not so much respect Beauty, as Variety of Ground and Soyle, proven for diverse Trees and Herbs. . . . In these we practice all Conclusions of Grafting, and Inoculating, as well of Wilde Trees, as Fruit-Trees, which produce many Effects. And we make (by Art) in the same Orchards, and Gardens Trees and Flowers to come earlier, or later than their Seasons; and to come up and bear more speedily than by their Naturall Course they doe. We make them also by Art greater much than their Nature; and their Fruit greater, and sweeter, and of differing Taste, Smell, Colour, and Figure, from their Nature. . . . We have also Meanes to make . . . one Tree or Plant turn into another.

A remarkable forecast of the program of plant propagation, plant breeding and experimental evolution in our modern institutions, which has not only advanced our knowledge of plant life, but has done so much to add to the health and pleasure and wealth and enlightenment of the world. The report of the British Parliamentary Commission, appointed about 1838 to report on the question of continuing the Royal Botanic Garden at Kew, speaks of it as "one of the first proofs of wealth and civilization."

It was more than one hundred years after Lord Bacon's prophecy that Duhamel du Monceau, a Frenchman prominent in the scientific and cultural life of his time, formed large collections of trees and shrubs on his two estates, devoting special attention to the rarest and finest, as Arthur Scott did here. Duhamel's collections appear to constitute the first arboretums developed primarily for the purpose of promoting the scientific study of trees. The results of Duhamel's studies based on this arboretum were published in 1755 under the title "Traité des arbres et arbustes qui se cultivient en France," and this is probably the earliest modern scientific work on trees.

Those who realize the civic and economic importance of arboriculture, silviculture and scientific forestry have always recognized the great advantages of an arboretum in promoting those sciences.

When the subject of forestry was just beginning to take shape as a major division of botanical science, in the last quarter of the nineteenth century, James Hutton Balfour, who became keeper (director) of the Royal Botanic Garden at Edinburgh in 1845, organized a portion of that garden as an arboretum just before he retired in 1879. The stated purpose of this was to facilitate the work of students of forestry in the University of Edinburgh. This is an early, if not the earliest, instance of a modern botanic garden developing an arboretum as one of its main divisions.

And now, what are the results of the scientific and educational work, made possible or promoted by botanic gardens and arboretums? It would not be possible, in one lecture, to enumerate all of even the more important results. They are published in books, reports and magazine articles that would make a large library. But two or three cases may be mentioned.

(1) For reasons of sentiment let us take a case near home. I have already spoken of Bartram's Garden. In the fall of 1765 John Bartram and his son, William, made a botanical reconnaissance through the south,

including Georgia. Near Fort Barrington, on the Altamaha River, they discovered a beautiful tree or shrub, hitherto wholly unknown to botanists. They named it *Franklinia altamaha,* after the great Philadelphian and the river on whose banks it grew. By the laws of nomenclature it should, perhaps, be called *Gordonia.* In 1777 William Bartram, traveling alone, visited the same locality, rediscovered the tree and secured either cuttings or seeds, which were brought back and planted in his garden, within a dozen miles of this spot. The tree had never been found wild before nor has it since. Apparently it has become extinct, except as a cultivated plant (like the Ginkgo). It is an old story in this vicinity. Within five years the trees in Bartram's garden were producing seeds. Not only was a wild species saved from extinction (a most valuable service to science), but our gardens and parks have been enriched with a new and beautiful shrub.

(2) The modern science of Genetics is scarcely forty years old. Its foundation was laid in 1866 by the publication of a paper on Plant Hybrids by the Austrian Monk, Gregor Mendel. Mendel's laws were based on his breeding experiments with the garden pea. Plant breeding was made possible by the discovery of the nature and functions of the organs of a flower, and that plants could be artificially hybridized.

These discoveries were all made by the experimental study of plants *in botanic gardens.*[4] Centuries of study of plants growing wild had not revealed these fundamental conceptions. The existence of a great collection of trees and plants in a botanic garden or arboretum facilitates and stimulates the study of plant life.

(3) The enrichment of American horticulture by the plant explorations of the Arnold Arboretum is well known throughout the world. To this arboretum we are indebted for Thunberg's barberry (*Berberis Thunbergii*), the paniculate clematis (*C. paniculata*), the tree lilac, the Katsura-tree (*Cercidiphyllum*), the climbing hydrangea, the evergreen bittersweet, the Amur cork-tree (*Phellodendron amurense*), and other woody plants, now among the most prized materials for ornamental horticulture.

In Loudon's extended account, in his book just cited, of the exchange of ornamental, timber and fruit trees between different countries—a matter of the highest importance—we learn that this took place largely between private and public arboretums.

Says Loudon, speaking in 1838:

> It would doubtless contribute to the spread all over the world of the trees and shrubs of North America, if one part of them could be seen in a grand national garden at New York, and another in a garden or arboretum at Charlestown; or if the whole could be assembled in one grand park or pleasure ground at Washington.

And then Loudon indulges in a reflection not strictly horticultural:

> If it is desirable for us [he says] that we should assemble in our country the trees and shrubs of every other similar climate, it must be equally desirable that the inhabitants of every other similar climate should possess all those species for which their climate is adapted. . . . The time for believing that the exclusive possession of any benefit contributes to the prosperity or happiness of nations is gone by [a little prematurely optimistic!] the principles of free and universal exchange and intercourse are found to constitute the surest foundation for the happiness of nations.

It took 75 years for Loudon's hope for arboretums in New York, Charleston and Washington to be two thirds fulfilled; how long will it take for his principle of the free interchange of commodities and courtesies between nations to be realized?

It is one of the glories, as well as advantages, of science that it must be international. There is no such thing as American chemistry or American physics or American horticulture—nor French nor German nor English. If horticulture, or any other science, had tried to be 100 per cent. American or 100 per cent. any other country, it would have been a miserable failure, and we should all have been intellectually and spiritually impoverished. Civilization is, after all, an international and inter-racial achievement.

But what opportunities for arboretums lie ahead? Three instances, only, may be cited to illustrate the extent and importance of the problems that confront arboretums in forest pathology only, not to mention other aspects of forestry and arboriculture.

(1) In 1904 a new tree disease known as the chestnut blight appeared in New York City. Within a short time it had destroyed practically all the chestnut trees within a radius of 200 miles. Scarcely a mature tree is now standing; all that are left are threatened with extinction. The financial loss for the entire United States is more than $50,000,000, and the once greatly valued chestnut lumber is no more available. In the face of this calamity foresters are helpless. The only control measure is to cut down all infected trees. The state of Pennsylvania alone has expended hundreds of thousands of dollars in fruitless endeavor to stop the spread of this disease.

(2) In 1909 the white pines of America were threat-

[4] The fact that plants have sex was proved experimentally in a botanic garden by Camerarius, director of the botanic garden at Tübingen, about 1691–94, but this fact was first glimpsed ten years before Camerarius by Sir Thomas Millington, professor of natural philosophy at Oxford University. He suggested that the stamens were the male organs of the flower, and this inference was based on his observations of the flowers growing in the Oxford botanic garden. Likewise, Koelreuter, who produced the first plant hybrids, conducted his experiments in a botanic garden—at Karlsruhe, where he was director.

ened with extinction by the "blister rust," a disease also imported from Europe. The value of the timber-stand that was threatened was estimated at more than $400,000,000. The only way yet known to keep this disease in check is to destroy all the currant and gooseberry bushes within a radius of many miles of any white pine—a drastic and difficult procedure, and only partially possible.

(3) At present, another priceless possession—our American elm, is threatened with extinction by the Dutch elm-disease. The only known way to check the ravages of this menace is to cut down and burn all infected trees as soon as they are discovered. We are as helpless in this respect as the dentists were in the medieval period of dentistry, when the only known remedy for a diseased tooth was to pull it out. The money value of the threatened elms—many millions of dollars—is perhaps exceeded by the esthetic value of these trees in field and park, on street and campus and dooryard.

Surely here are needs not yet adequately met and challenges to any arboretum for a service of the highest scientific and economic importance.

The study of forest pathology is, of course, only one of the opportunities and responsibilities of an arboretum. By cooperating with garden clubs and other horticultural organizations it can render services that are important in fostering a general public interest in all aspects of plant life.

At such an arboretum as this there might, in time, be developed a training school to prepare young men for practical work in dendrology and arboriculture, with special reference to work on college campuses, private estates and the park departments of our cities.

An arboretum also serves to exhibit a rich collection of trees and shrubs, so that people may become acquainted with such material, develop their taste and improve the planting and beautifying of their own grounds. And (of special importance for a college) the presence of an arboretum, like this one at Swarthmore, not only facilitates and enriches the formal instruction in botany, but in a more passive way contributes to the educational atmosphere of undergraduate life.

Sir Frederic Kenyon, in his Romanes Lecture at Oxford, spoke of museums as an integral part of the system of national education, "a part of the nation's contribution to civilization," "a part of the response to the need that man has for quality in his life as well as quantity." And arboretums, being a highly specialized outdoor museum, may make the same kind of contribution to the life of the spirit and the promotion of general culture.

We are living in troubled times. Forces are at work that aim to introduce a new order of things into human life. Their program for realizing Utopia appears to involve the abandonment or destruction of much of the precious heritage of freedom and liberty of life and thought for which the human race has struggled and fought for many generations. No one could seriously question the fact that the content of college education should enable young men and women to understand the pressing problems of the moment, to view them in perspective and to consider dispassionately the possibilities of solution.

But, urgent as these subjects are, they are not the only matters that should be brought to the serious attention of college students. The spontaneous interests of thousands of students are outside the realm of the practical affairs of politics and social science, and the most important problem of our colleges and universities is to help students discover what their major interest in life is and to provide the richest opportunities possible for the cultivation of those interests.

Aside from all questions of the practical aspects of arboriculture and forestry many students will discover in the environment of an arboretum the major enthusiasm of their lives. From the standpoint of education, that is more important than any information that may be learned about trees and shrubs—or economics and history.

The establishment of this arboretum is, *ipso facto*, an enrichment of the cultural opportunities of Swarthmore College.

Some years ago, in another address, I noted how seldom our colleges have utilized their grounds for educational ends. There is no inherent reason why our college campuses should be only parks where the educational plant is located. They might just as well be an integral part of the educational plant—an outdoor extension of the laboratories of botany and horticulture.

And things may be educational without the aid of formal instruction. It is an education in slovenliness to live in an environment of disorder, just as it is an education in esthetics to be surrounded by beauty; lectures on art may help, but they are not essential. If students pass daily through a campus with the trees and shrubs grouped on a botanical basis and attractively labeled, many of them will incidentally, and more or less unconsciously, *absorb* a certain amount of information, and have aroused within them a certain amount of interest in plant life. More than one scientist has received his initial interest and urge by merely strolling through the halls of a museum as a boy.

The idea of an arboretum-campus has been struggling for realization in America for nearly 300 years —from the first decade of Harvard College. Harvard has just celebrated its three hundredth anniversary.

How small the beginnings may be that eventuate in great accomplishment is illustrated by the fact that the second president of Harvard, Dr. Dunster, in his first years, on a salary of £55 a year, was not only charged with all the duties of administration but gave all the instruction. For five days in each week he was occupied with lecturing from 8 A.M. to 5 P.M. His lectures were on such diverse subjects as arithmetic, astronomy, divinity, politics, rhetoric, Aramaic, Syriac, Hebrew and Greek.

His program recalls that of Theophrastus. When did President Dunster prepare his lectures, read examination papers, attend to administration? And *when* did he do his research!

For our purpose this afternoon we note with interest, and perhaps with some surprise that on every Saturday during the spring and fall quarters of the year, from 2 to 3 P.M., President Dunster conducted a botany class, lecturing on the "Natùre of Plants." "This," says the historian of Harvard College, "signalizes the inauguration of Botany; a light subject, suitable for hot Saturday afternoons in July and August. . ."!

We are familiar with the opinion, commonly held a generation ago, that botany was largely a subject for girls' finishing schools, but this is the only time I ever saw it characterized as "a light subject," suitable for hours of languor on hot summer afternoons.

Morrison thinks that the phrasing of the title of Dunster's course—"Nature of Plants"—indicates that the teaching consisted in reading to the students some abbreviated edition of Aristotle's *De Plantis,* or possibly Theophrastus's book of similar title.

Morrison also thinks it would be rash to assume that President Dunster adjourned his botany class to the Harvard "Yard" in order to study nature at first hand. Perhaps it would be, for one to whom scientific method was doubtless a closed book, and who had such a heavy schedule of teaching and administration as Dunster had.

However, Dunster's teaching must have been very inspiring, for the laws of Harvard College forbade any student to show a light in his study *before* four o'clock in the morning.

In 1672 Dr. Leonard Hoar became president of Harvard, and is said by Morrison to have had a "broader purpose" for the college than any other president before Eliot. President Hoar referred to himself as an amateur botanist. In a letter to the great chemist, Robert Boyle, he enumerates some of his ambitions for Harvard, and specifies, "A large well-sheltered garden and orchard for students addicted to planting."

Now, after nearly three hundred years, Harvard has the Arnold Arboretum, one of its most important and best known departments. Smith, Wellesley, Mt. Holyoke and several other colleges now have botanic gardens on their campuses; Michigan, Cornell, Pennsylvania and some other universities have arboretums that do not include the campus; but only a few institutions —the University of North Carolina, the Friends School at Westtown (Pennsylvania), and now Swarthmore—have developed their campuses as arboretums or as integral parts of an arboretum.

The advantage, for studying botany or horticulture, of having at hand such a plantation as a botanic garden or arboretum hardly needs to be further emphasized. There is assembled, in small compass, a collection of plants from all over the world—material that could not otherwise be seen except by extensive travel, prohibitively expensive for most students of plant life. Moreover, the plants, trees and shrubs have been arranged in systematic sequence, or on some other botanical basis, and they have been identified and labeled, all of which facilitates the use of the collection for study and instruction.

Such a collection, supplemented by a suitable herbarium and library, and administered by a competent staff of investigators and teachers, with the *esprit de corps* of a body of students, and surrounded by the academic atmosphere of a great educational institution like Swarthmore, can not help but be a stimulus to delightful and profitable study and an important factor in preparation for life work in the field of one's greatest enthusiasm.

These, and more, are the advantages that have been made possible at Swarthmore by the Arthur Hoyt Scott Foundation. It is a wonderful educational opportunity, and I hope that funds will become available with increasing abundance to make possible in this center, so rich in botanical tradition and achievement, the development of a scientific and educational program correlated with a campus-arboretum, and preserving the high standards of scholarship that have always characterized the various departments of Swarthmore College.

This foundation, commemorating the worth-while interests and high ideals of Arthur Hoyt Scott, lover of trees and of Swarthmore, may be made not alone to enrich the undergraduate curriculum of this college, but to serve botanical and horticultural science and education on a national and international scale, to foster a love of beauty, to emphasize the importance of a study of plant life, and to promote an interest in the conservation of our natural resources. The foundation is laid; the superstructure has been begun; the vision, the enthusiasm and the will to accomplish are here in full measure. To paraphrase St. Paul: This college has planted, your Apollos has watered; may God give the increase in full measure of abundance.

OBITUARY

WILLIAM HARDING LONGLEY

DR. WILLIAM HARDING LONGLEY, professor and chairman of the department of biology in Goucher College and executive officer of the Tortugas Laboratory of the Carnegie Institution of Washington, died on March 10, 1937, after a protracted illness. In his passing, zoology has lost one of its keenest students and Goucher College one of its most stimulating teachers.

Dr. Longley was born in Paradise, Nova Scotia, on October 27, 1881. He received the B.A. degree from Acadia University in 1898. After serving for five years as a principal in the public schools of Nova Scotia, he entered Yale, from which he received the degrees of B.A. in 1907, M.A. in 1908 and Ph.D. in 1910. After acting as instructor at Yale for one year, he became in 1911 instructor in biology and associate professor of botany at Goucher College. In 1914 he was made professor of botany and in 1919 professor of biology. In 1917 he succeeded Professor Wm. E. Kellicott as chairman of the department. He received in 1931 the honorary degree of doctor of science from Acadia University. He was a member of Phi Beta Kappa, Sigma Xi and numerous scientific societies.

In 1911 Dr. Longley went to the Dry Tortugas Laboratory of the Carnegie Institution of Washington as collector. While there he became interested in the possibility of using tropical reef fishes as material with which to test experimentally the Darwinian concepts of protective coloration and mimicry. Returning the following summer as investigator, he devoted this and many succeeding seasons to an intensive study of the rôle of color and pattern in the life of the fishes of the tropical reefs. During these years there developed between him and Dr. Alfred G. Mayer, director of the laboratory, a deep intimacy and a similarity of interest which made it but natural that he should be asked, upon the death of Dr. Mayer, to become director of the laboratory and to carry on the excellent tradition of accomplishment established by the latter. Under his leadership, the work of the laboratory grew rapidly, many eminent investigators from this country and abroad finding there a much-needed opportunity.

In order to discover the degree to which color, pattern and the ability to change both color and pattern are of use to the reef fishes, it was necessary to live with them for long stretches of time, to become acquainted with their habits and their ecological relations. Consequently he spent many hours a day under water, using a diving hood, recording observations by means of wax tablets and a water-tight photographic outfit. He thus came to know the tropical reef fishes of the Gulf of Mexico as no other man has ever known them.

The scope of these studies gradually widened until they covered the tropical reef fishes of the world. Under the auspices of the Carnegie Institution, he made several trips to Hawaii and Samoa, and on one occasion spent the better part of a year in a trip around the world, much of the time being spent in the Dutch East Indies. By means of undersea studies, he came to know with more or less intimacy the structure, habits and ecological relations of more than 350 species of Gulf fishes and over 400 species of Pacific fishes. He was also well acquainted with museum material. Under the same auspices, he was able to visit the principal museums of the world and to study the type specimens of most of the described species of reef fishes.

Concerned originally in testing the Darwinian theories of protective coloration and mimicry, his interests gradually spread with the years. He became interested in species, not from the purely taxonomic point of view, but from the standpoint of the student of evolution. This study led to a comprehensive statistical theory of the origin and spread of species, which was his chief concern in later years. As an incident to his study of species, for he never considered it more than incidental, his intimate knowledge of reef fishes in their native habitats as well as of type specimens in the museums led to a profound modification of their classification. He reduced over 20 per cent. of the recognized species of Gulf reef fishes to synonymy, and as a result the surviving species were seen to constitute clearly separable and distinct natural entities.

In his manner of working, Dr. Longley had many of the traits of Charles Darwin. He was his own severest critic, checking and confirming his facts with painstaking care and refusing to adopt his own hypothesis until every other alternative had been satisfactorily disposed of. His extreme caution led him to refrain from publication as long as any uncertainty existed with regard either to data or to the conclusions to be drawn from accumulated facts. Consequently, he published relatively seldom, apart from annual reports in the Year Book of the Carnegie Institution of Washington. At the time of his death he had almost ready for the printer the manuscript of an extensive monograph on the reef fishes of the Gulf of Mexico. This work, richly illustrated with undersea photographs and drawings from life, is a model of thoroughness and accuracy of observation and sets a new standard in the manner in which it emphasizes the necessity of knowing the living organism in its natural habitat. While unfinished, the manuscript is apparently in such a condition that it can be published. Whether his extensive notes on the

Pacific fishes can be utilized is at the present writing uncertain.

Dr. Longley was an inspiring teacher. Due largely to his influence, most of the major students in his department have gone into some form of active biological work. Many of his students have taken doctorates and a goodly number have made, and are making, significant contributions to knowledge. Few teachers in strictly undergraduate institutions have seen as many of their students entering fields of active research as he. His own passionate enthusiasm for research, and his deep personal interest in his students, of which they were keenly aware, made him an unusually successful teacher.

Dr. Longley was known to his colleagues as a man of sound judgment, endowed with more than his share of good hard common sense. He was a practical idealist, combining the highest standards in life and work with a realistic understanding as how best to maintain these standards. He will be missed, not only as an investigator, but as a stimulating and helpful friend and colleague.

In 1908, Dr. Longley married Hazel Fowler Baird. Mrs. Longley and three children survive him.

RALPH E. CLELAND

RECENT DEATHS AND MEMORIALS

DR. WILLIAM MORTON WHEELER, professor emeritus of entomology at Harvard University, died suddenly on April 19 at the age of seventy-two years.

DR. ALBERT POTTER WILLS, since 1909 professor of mathematical physics at Columbia University, died on April 17 at the age of sixty-four years.

THE *Journal* of the American Medical Association reports that the Arthur B. Duel Facial Palsy Clinic has been established at the Manhattan Eye, Ear and Throat Hospital in memory of the late Dr. Duel, who founded a clinic for facial palsy in the hospital in 1933 and was in charge of it until his death. Dr. Thomas G. Tickle, a former associate of Dr. Duel, is in charge of the clinic and will offer a course in the surgical technic and treatment of facial paralysis.

A COMMITTEE headed by Professor Sergent has been appointed to collect funds for a statue of Laënnec to be erected in Paris on a site in front of the Charité Hospital. The amphitheater in which Laënnec taught in the latter institution still exists and the wards in which the discoverer of auscultation first applied this method faced the square in which the proposed statue will be placed.

SCIENTIFIC EVENTS

THE DEPARTMENT OF HEALTH AT YALE UNIVERSITY

THE scope of the work of the Yale Department of University Health, which has general supervision of student health, including physical education, definitely increased last year, according to a university bulletin. This increase was especially marked in the medical, surgical and physical therapy departments. There were 21,045 medical consultations; 6,327 surgical consultations and 4,885 physical therapy consultations.

All entering students were tested with an improved form of tuberculin called "purified protein derivative." The total number of undergraduate freshmen tested with tuberculin was 846, of whom 42.4 per cent. reacted positively. The number of entering students from all other departments was 608, of whom 56.9 per cent. reacted positively. For the combined number the percentage of positive reactors to tuberculin was 48.4. The comparable figures for the year 1931–32 were 53.9 positive for freshmen, 71.7 positive for graduate students, or a combined percentage of 62.1 positive. The bulletin points out that "This marked drop in positive reactions to tuberculin presumably indicates a lessened exposure to which this group has been subjected, and is consonant with results in other universities where this procedure is carried out."

Under the guidance of the department, 3,780 students last year took exercise for a total of 214,417 periods. The freshman program included instruction in correct body mechanics, optional sports and exercises as well as tests and instruction in leisure skills and games. The results of the tests given in recreational sports showed that 810, or 92 per cent., could swim; 316, or 37 per cent., could play golf, and 368, or 44 per cent. could play squash. All the 846 members of the freshman class, with the exception of sixteen who were excused by the department, could swim before the year was over.

Following the orthopedic examinations of the freshman class, 533 men were assigned to take corrective exercises. Before the end of the compulsory period, 66 per cent. of the total group were released. Of the entire number taking the corrective exercises, only a few more than 10 per cent. failed to pass the final examination. Supplementing the orthopedic examination a postural photograph of individuals with poor body mechanics is taken before any corrective work is given. Upon release from a corrective class, another photograph is taken to show improvement over the initial posture.

REORGANIZATION OF THE DEPARTMENT OF FORESTRY AT CORNELL UNIVERSITY

PURSUANT to suggestions made by the Board of Regents of the University of the State of New York and the State Department of Education, the trustees of Cornell University and of the New York State College of Forestry at Syracuse University have recently taken action that will result, after July 1, in changes in the teaching programs in the field of conservation offered by these two institutions.

After July 1, according to an announcement made by Dean Carl E. Ladd, of the New York State College of Agriculture at Cornell University, all instruction in professional forestry, both graduate and undergraduate, offered under state auspices, is to be concentrated in the New York State College of Forestry at Syracuse, and similarly all professional instruction in wildlife conservation and management in the New York State College of Agriculture at Cornell.

As regards forestry this action was foreshadowed when in February, 1933, the Board of Trustees of Cornell University ordered that undergraduate instruction in professional forestry be terminated in June, 1936, with the graduation of the classes of undergraduate students of professional forestry then in residence. With the granting, at the end of the present college year, of the degree of master of forestry to the graduate students in forestry now at the university, Cornell will cease to confer that professional degree and the department of forestry will no longer receive either graduate or undergraduate students of professional forestry.

The department of forestry will thereafter limit its instruction to courses, non-professional in character, designed to round out, as to forestry, the programs of students of agriculture or of wildlife conservation and management. The extension work of the department of forestry will be continued as in the past, following the general program which has been actively pursued in recent years.

To serve students in any department of the university who are especially interested in farm or woodland forestry, or who desire general information about forestry and the broader aspects of conservation, including wildlife conservation in relation to forestry, the courses covering these subjects will be continued. Graduate students in fields allied to forestry may elect to work in subjects other than professional forestry under the direction of members of the staff of the department of forestry as candidates for the degrees of master of science and doctor of philosophy.

The development of the research forest properties, and certain phases of other research work in forestry are continued. Research in forest soils, under Professor R. F. Chandler, Jr., is not affected by this reorganization, nor are the opportunities for graduate study of forest pathology, or of the fundamental aspects of the biological sciences in allied departments of the university.

In connection with this reorganization, Professor Cedric H. Guise has been transferred from the department of forestry to the office of the director of resident instruction of this college, where he will serve as professor of personnel administration. His transfer took effect on February 15.

SPECIAL SUMMER PROGRAM ON SPECTROSCOPY AND ITS APPLICATIONS AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A FIFTH spectroscopy conference will be held at the George Eastman Research Laboratories of the Massachusetts Institute of Technology on July 19, 20 and 21, repeating to a considerable extent the type of program presented at the conferences held during the past four summers. Reports will be given by spectroscopists from university and industrial research and analytical laboratories and by biologists, metallurgists, geologists, chemists and physicists who have found spectroscopic equipment useful in their investigations.

Morning and afternoon meetings will be held during all three days. A program of papers and discussions is being prepared on analysis of materials by the emission spectrum, absorption spectrophotometry, photographic photometry, biological and chemical effects of spectral radiation and industrial applications of spectroscopy. Copies of the detailed program of the conference will be sent to any one interested, but as the attendance at the conference will this year be limited to two hundred, those expecting to attend from a distance are urged to signify in advance if possible their intention of attending. No fee is charged in connection with the conference. Its object is to promote cooperation between workers in various scientific and industrial fields.

The usual summer courses on practical and applied spectroscopy will be offered at the institute between June 14 and July 24. The invitation of recent years is being extended to qualified investigators to make use during the coming summer of the spectroscopic facilities of the institute in connection with their researches. Members of the conference will be expected to be responsible only for any expensive equipment required specially for their own investigations which is not already available in the laboratory.

Requests for fuller information regarding the conference, including titles of the papers to be presented, and for data regarding the summer courses and spectroscopic research, should be addressed to Professor G. R. Harrison, Department of Physics, Massachusetts Institute of Technology, Cambridge, Mass.

THE MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY AT PHILADELPHIA

THE seventy-first meeting of the American Electrochemical Society will be held at the Hotel Benjamin Franklin, Philadelphia, on April 28, 29 and 30.

One of the main sessions will be devoted to the electrochemical phenomena which have been observed in living cells. Among those who will participate in the discussion are: Professor A. H. Abramson, of Columbia University; Messrs. W. J. V. Osterhout, L. Michaelis, D. A. MacInnes and L. G. Longsworth, of the Rockefeller Institute for Medical Research, and Professor E. J. Cohn, of the Harvard Medical School.

Speakers at a session on the problems of industrial catalysis will be: P. K. Frolich, of the Standard Oil Development Company; V. N. Ipatieff, of the Universal Oil Products Company; A. T. Larson, of the du Pont Company; H. S. Taylor, of Princeton University, and Messrs. P. H. Emmett and S. Brunauer, of the U. S. Department of Agriculture.

There will be also technical sessions on electrode phenomena in aqueous solutions and on organic electrochemistry.

On Thursday evening Dr. Detlev W. Bronk, since 1929 Johnson professor of biophysics at the University of Pennsylvania, will give an address on "Electrical Methods in the Study of Nerve and Muscle." The retiring president, Dr. Duncan A. MacInnes, of the Rockefeller Institute for Medical Research, will deliver his address, entitled "The Contribution of Willard Gibbs to Electrochemistry," on Friday evening. At the luncheon on Saturday Dr. H. C. Rentschler, of the Westinghouse Lamp Company, will give an address entitled "Photo Cells."

Friday morning will be devoted to visits to industrial firms, including the Edward G. Budd Manufacturing Company and the Leeds and Northrup Company, followed by a luncheon given by the latter company.

THE RESEARCH FOUNDATION OF THE OHIO STATE UNIVERSITY

IN SCIENCE for November 27 an account is given of the organization of the Ohio State University Research Foundation. The corporation is not for profit and none of the officers of the corporation nor of its members receive remuneration in any form. Its object is to bring about a closer cooperation between the university and industry, particularly in making the laboratory and research facilities of the university of greater helpfulness in solving the problems of industry.

Officers elected to initiate the foundation are: George W. Rightmire, *president;* Carl E. Steeb, *treasurer;* Hurlbut S. Jacoby, *secretary and director.* All officers are on the university staff, Dr. Rightmire being president, Mr. Steeb, business manager, and Mr. Jacoby, director of industrial research. The directors are: Charles E. MacQuigg, New York City; Thomas Midgely, Jr., Detroit; Charles F. Kettering, Detroit; J. L. Morrill, Columbus; Harry A. Toulmin, Jr., Dayton; Arno C. Fieldner, Washington, D. C.; Charles F. Michael, Bucyrus; E. E. Ware, Cleveland; James F. Lincoln, Cleveland; Harry A. Caton, Coshocton, and Julius F. Stone, Mr. Rightmire, W. W. Charters, John F. Cunningham and William McPherson, Columbus.

The foundation has a membership of fifty-five, including ten councilors as follows: from national industries, ten Ohio State alumni members, ten councilors from Ohio industries, members of the university board of trustees, deans of the various Ohio state colleges, directors of campus research bureaus and the director of the Ohio Agricultural Experiment Station at Wooster.

National councilors are: Willard Chevalier, McGraw-Hill Publishing Co., New York; L. W. Chubb, Westinghouse and Manufacturing Co., East Pittsburgh; Saul Dushman, General Electric Co., Schenectady; Harvey Fletcher, Bell Telephone Laboratories, New York; C. F. Hirshfeld, Detroit Edison Co., Detroit; C. F. Kettering, General Motors Corporation, Detroit; Henry G. Knight, Bureau of Chemistry and Soils, Washington, D. C.; C. E. MacQuigg, National Carbide and Carbon Corporation, New York; Thomas Midgely, Jr., Ethyl Gasoline Corporation, Detroit; Robert B. Sosman, U. S. Steel Corporation, Kearny, N. J.

Industrial councilors are: R. K. Brodie, Procter and Gamble Co., Ivorydale; Harvey Firestone, Jr., Firestone Tire and Rubber Co., Akron; William V. Fisher, Hocking Glass Company, Lancaster; W. J. Harshaw, Harshaw Chemical Co., Cleveland; W. T. Holliday, Standard Oil Co. of Ohio, Cleveland; Charles R. Hook, American Rolling Mills Co., Middletown; J. F. Lincoln, Lincoln Electric Co., Cleveland; Charles F. Michael, Ohio Locomotive Crane Co., Bucyrus; Alexander Thomson, Champion Paper and Fibre Co., Hamilton; E. E. Ware, Sherwin-Williams Co., Cleveland.

Alumni members of the foundation are: Firman E. Bear, American Cyanamid Co., New York; D. J. Brumley, American Railway Engineering Association, Chicago; H. R. Drackett, Drackett Co., Cincinnati; A. C. Fieldner, U. S. Bureau of Mines, Washington, D. C.; William N. King, New York Central Railroad, Cleveland; Roy D. McClure, Henry Ford Hospital, Detroit; J. L. Morrill, Ohio State University, Columbus; F. H. Riddle, Champion Spark Plug Company, Detroit; G. F. Schlesinger, National Paving Brick Association, Washington, D. C.; H. A. Toulmin, Jr., Toulmin and Toulmin, attorneys, Dayton.

SCIENTIFIC NOTES AND NEWS

THE annual meeting of the National Academy of Sciences will be held in Washington on April 26, 27 and 28. The evening lecture will be given by Dr. George H. Whipple, of the University of Rochester, his subject being "The Romance of Hemoglobin."

DR. ERICH TSCHERMAK has been elected a correspondent of the Academy of Sciences, Institute of France, in the section of rural economy. He fills the place left vacant by the death of Theobald Smith.

THE Pasteur Medal of the French Society of Clinical Biology has been awarded to Professor L. van Itallie, of the University of Leiden.

THE London *Times* announces that the council of the Iron and Steel Institute has awarded Bessemer gold medals for 1937 to Colonel N. T. Belaiew and to M. Aloyse Meyer. Colonel Belaiew, of Paris, a former pupil of Professor Tschernoff, of the Military Academy, Petrograd, is an authority on metallurgy. M. Aloyse Meyer, of Luxemburg, is an honorary vice-president of the Iron and Steel Institute, and is known as the head of the Société Anonyme Arbed, the Luxemburg combine, and the second largest iron and steel company in Europe.

DURING the April meeting of the International Council of Scientific Unions in London an honorary degree will be conferred by the University of London on the president of the council, Professor N. E. Nörlund, director of the Geodetic Institute of Copenhagen.

Nature states that the Central Executive Committee of the U.S.S.R. conferred the Order of Lenin on Professor A. N. Bach, on the occasion of the fiftieth anniversary of his scientific activity, for his work on the chemistry of photosynthesis, respiration and enzyme action. Professor Bach celebrated his eightieth birthday on March 17.

DR. HENRY V. HOWE, director of the School of Geology of the Louisiana State University, was appointed secretary-treasurer of the Society of Economic Paleontologists and Mineralogists at the recent meeting in Los Angeles.

DR. C. S. MUDGE, associate professor of dairy industry and associate dairy bacteriologist in the experiment station of the University of California College of Agriculture at Davis, was elected at the San Francisco meeting chairman of the Western Branch of the Society of American Bacteriologists. Dr. Mudge succeeds Dr. Paul J. Beard, of Stanford University. He will have charge of the arrangements for the meeting of the national organization in San Francisco next year.

DR. ROBERT P. WALTON, assistant professor of pharmacology at the School of Medicine of Tulane University, has been appointed professor and head of the department of pharmacology of the School of Medicine of the University of Mississippi.

DR. ROWLAND W. LEIBY has become assistant professor of entomology in the extension department of Cornell University, to fill the vacancy caused by the death on January 11 of Professor Cyrus R. Crosby.

VLADIMIR MISSIURO, professor at the Central Institute of Physical Education of the University of Warsaw, has been appointed research associate in the Harvard Fatigue Laboratory for the current academic year. Dr. José H. Aste-Salazar has been appointed research assistant.

DR. LINDA B. LANGE, associate professor of bacteriology at the School of Hygiene and Public Health of the Johns Hopkins University, has been appointed professor of bacteriology and immunology at the Woman's Medical College of Pennsylvania, Philadelphia.

THE department of mining and metallurgy of the Massachusetts Institute of Technology has been divided into two distinct fields of professional education; the department of mining engineering will be administered under the direction of Professor W. Spencer Hutchinson. This department will include the course in petroleum production. There will be established a new department of metallurgy, which will be directed by Dr. Robert S. Williams, professor of physical metallurgy. This department will include the course in ceramics.

AT the College of Engineering of the Carnegie Institute of Technology, beginning next autumn, courses in chemical engineering will be administered under two separate departments instead of under one as at present. Dr. Thomas R. Alexander, associate professor of inorganic chemistry, will become acting head of the department of chemistry, and Dr. Warren L. McCabe, professor of chemical engineering, will be the head of the department of chemical engineering.

PROFESSOR A. E. TRUEMAN, Chaning Wills professor of geology in the University of Bristol, will succeed Professor E. B. Bailey in the chair of geology at the University of Glasgow. Dr. Bailey was recently appointed director of the Geological Survey of Great Britain.

DR. N. K. ADAM, research chemist in Imperial Chemical Industries, Ltd., has been appointed professor of chemistry in University College, Southampton.

DR. AARON L. TREADWELL, since 1900 head of the department of zoology of Vassar College, having reached the age of seventy years, will retire in June. He will be succeeded by Dr. Rudolf T. Kempton, now assistant professor in the department of biology at Princeton University.

DR. WALTER L. JENNINGS, head of the department of chemistry and chemical engineering at the Worcester Polytechnic Institute, will retire from teaching at the end of the current academic year. He will be succeeded by Dr. Frederic R. Butler.

AT Columbia University Dr. Leslie C. Dunn, professor of zoology, and Dr. James W. Jobling, professor of pathology, have been elected members of the university council. Dr. Dunn will serve as chairman of the committee on instruction.

DR. PAUL POPENOE has resigned from the Human Betterment Foundation at Pasadena, Calif., of which he has been secretary since its organization, and hereafter will devote all his time to the Los Angeles Institute of Family Relations, of which he has also been general director from its incorporation seven years ago.

PROFESSOR AUGUSTO BONAZZI, for a number of years connected with the Estacion Experimental Agronomica of Santiago de las Vegas, Havana, has recently assumed his work as director of research for the Department of Agriculture and Animal Industry at Caracas, Venezuela.

DR. WALTER B. CANNON, of the Harvard Medical School, is honorary chairman of the Greater Boston Committee to Aid Spanish Democracy. Sponsors of the movement include President Karl T. Compton, of the Massachusetts Institute of Technology; President Daniel L. Marsh, of Boston University, and Dr. John Albert Cousens, president of Tufts College.

IN response to a request for an opinion on "The Place of Science in National Planning," by Senator Robert J. Bulkley, chairman of the United States Senate Committee on Manufactures, the American Institute sponsored a discussion at the Chemists' Club, New York City, on April 22. Dr. Willis R. Whitney, of the General Electric Company; Waldemar Kaempffert, science editor of *The New York Times;* Dr. George Baehr, trustee of the New York Academy of Medicine; Julius H. Barnes, formerly chairman of the U. S. Chamber of Commerce, and others were present and led the discussion.

DR. E. V. MCCOLLUM left on April 2 for Geneva. He represented this country in nutrition at a meeting of the Mixed Committee of the Health Section of the League of Nations, which held sessions from April 10 to 17.

AT the University of Michigan, leave of absence during the first semester, 1937 to 1938, has been given to the following members of the faculty: Dr. Ermine C. Case, professor of historical geology and paleontology; Dr. Samuel A. Graham, professor of economic zoology; Dr. Burton D. Thuma, assistant professor of psychology; Dr. Lewis E. Wehmeyer, assistant professor of botany. Leave of absence for the entire year has been accorded to Dr. Otto Laporte, associate professor of physics; to Horace W. King, professor of hydraulic engineering, and to Stephen S. Attwood, associate professor of electrical engineering.

DR. HUGO OBERMAIER, professor of prehistory at the University of Madrid, recently lectured before the German Archeological Institute at Rome.

PROFESSOR A. A. ALLEN, of Cornell University, addressed a joint meeting of the Washington Academy of Sciences and the Biological Society of Washington on April 8. The lecture on "American Ornithology, Past and Present," was illustrated by lantern slides and motion pictures with sound recordings.

SIGMA XI lectures on "Internal Secretions in Reproduction," by Dr. Edgar Allen, professor of anatomy at Yale University, were given at Tulane University, the University of Alabama, Virginia Polytechnic Institute and the University of Maine from March 31 to April 8.

DR. C. V. ARIENS KAPPERS, director of the Central Institute of Brain Research of Amsterdam and professor of comparative neurology at the university, addressed the third-year class of the Long Island College of Medicine on April 7. His subject was "The Autonomic Center of the Hypo-Thalamus."

THE eighth annual meeting of the American Association of Physical Anthropologists was held at Cambridge, Mass., on April 8, 9 and 10. The annual public address was delivered by Dr. H. L. Shapiro, of the American Museum of Natural History, the subject being "The Pitcairn Islanders." At the dinner Professor Wm. F. Peterson, of the University of Illinois, gave an illustrated address on "Environmental Effect and Organic Differentiation."

THE annual meeting of the American Association of Pathologists and Bacteriologists will be held in Atlantic City, N. J., on May 3 and 4, 1938, in conjunction with the Congress of American Physicians and Surgeons.

THE third annual meeting of the New York Geographical Association will be held on May 1. There will be a series of papers during the morning session, from nine-thirty to twelve o'clock; a field trip in the afternoon, starting at two o'clock; and a banquet in

the evening at six-thirty. Professor Erwin Raisz, of the Institute of Geographical Exploration at Harvard University, will be a guest speaker. The special committee on the status of geography in the schools of New York State will present its report.

THE Division of Biology of the University of Georgia announces a meeting on May 7 and 8 of the biologists of the southeastern states at Athens, Georgia. Papers on original research and accounts of biological work in southeastern institutions will be presented. The principal address will be given by Dr. L. O. Kunkel, member of the Rockefeller Institute for Medical Research, who will speak on some of the recent developments in virus research.

THE Missouri Public Health Association will hold its thirteenth annual meeting on April 29 and 30 at the Kentwood Arms Hotel, Springfield. A program of particular importance to the public health interests of Missouri will be presented. Papers on tuberculosis, cancer, venereal diseases, maternal welfare, crippled children's service, oral hygiene and malaria are among those that will be given. The final paper which will be given pertains to the future of public health in Missouri under the Social Security Program.

DISCUSSION

RUBBER PRODUCTION FROM CASTILLA AND HEVEA

CAUCHUC, guttapercha, balata, chicle and guayule belong to a series of organic materials sharing such properties as plasticity, resilience and tensile elasticity, dissolving in ether, chloroform, benzol and other liquid hydrocarbons, combining readily with sulfur and the halogen elements, but otherwise inert. No general function in the plant economy has been demonstrated, but the various forms of rubber may be viewed as excretory products and associated with resins, tannins and lignins. As with sugar from cane and beet, rubber of the same nature is obtainable from the Castilla or Central American rubber tree, and from the Hevea or Para rubber tree of Brazil, cultivated in the East Indies, although the trees belong to unrelated families and different methods of extraction are required.

Many kinds of rubber-bearing trees, vines and shrubs have been exploited in the wild state, but only three systems of cultural production have been worked out, one with manual tapping of the Hevea tree, the others with mechanical extraction of guayule and gutta-percha. The mechanical processes are definitely unsuited to the thin Hevea bark, but may be adapted to the thicker latex layer of the Castilla tree. Both trees have been introduced in southern Florida and have reached the stage of flowering and seeding, so that local tests of cultural behavior and methods of extraction may be made.

The special value of Hevea as a plantation tree lies in its system of microscopic latex tubes branching and anastomosing as a continuous network through the inner bark, seeping the creamy fluid to a single cut, replenishing the wound area and restoring the bark pressure. Tapping is repeated by paring the rim of the cut, with the latex supply becoming more liquid and the flow increasing in successive days, the so-called "wound response." The method of wound renewal was discovered by Ridley at Singapore in 1889 and led to commercial planting in 1896, twenty years after Wickham took the seeds from Brazil.

Castilla has simple latex tubes, not branched or connected, so that the Ridley tapping method does not apply, but the latex of Castilla is more abundant and was much easier to collect by the native methods, though the trees were soon exterminated. Castilla was tapped with many cuts, in Mexico by climbing the trees and gashing the bark obliquely, in South America by felling and circling the trunks. Several pounds of rubber were obtained, 30 to 50 pounds from large trees being credibly reported, though only a small part of the latex is forced out by the bark pressure.

An oxidizing enzyme in the sap of Castilla blackens and softens the rubber to a sticky paste, but simple heat treatments avoid such damage. Even in logs lying in the sun the enzyme may be destroyed, and the latex then coagulates in pale elastic threads that separate readily from decaying bark, as in retting for mechanical extraction. Small drops of pure latex sometimes exude when "scrap rubber" is pulled from tapping cuts and coagulate without discoloring. Castilla latex corked in glass bottles shows no visible changes, and was the "liquid rubber" brought from Central America for the early experiments in England by Hancock and Faraday, in 1822 and 1826. Records of Castilla go back to Bernardino de Sahagun, who reached Mexico in 1529 and wrote of "ulli" as a black elastic resin with many medicinal uses, and made into bouncing balls.

Many reference works convey the impression of Castilla being confined to Central America and Mexico, whereas even greater areas were occupied in South America, from Panama through Colombia, Ecuador, Peru, Bolivia and Brazil, including practically the entire range of *Hevea brasiliensis* in the Amazon valley, to Matto Grosso and Para. When Richard Spruce reached Brazil in 1849 commercial tapping of Hevea was "limited to the immediate environs" of Para, but

a few years of rising prices turned thousands of people to gathering rubber "nearly throughout the Amazon and its principal tributaries." Spruce learned of an earlier period when the rubber trees had been cut down, and supposed that a discovery had been made, of obtaining more rubber "by successive tappings of the same tree," but a recent transition from Castilla is indicated, and some of the up-river tribes still did not know of rubber being obtained from Hevea. Exports of Castilla rubber from eastern Peru, previously carried over the Andes, began to move down the Amazon in 1853, as Schurz has recognized, and "caucho" still comes in commercial quantities from many outlying districts in Brazil.

The discovery of Hevea often is dated from 1736 when the French astronomer La Condamine landed at Manta and traveled to Quito through the Pacific coast province of Esmeraldas where the elastic resin called "caoutchouc" was obtained, but from the methods of collecting the latex and forming long rolls of rubber to burn as candles or torches, the trees could not have been Hevea. West of the Andes no Hevea has been found, but Castilla still grows in Esmeraldas and in the upper Amazon valley, where rubber-gathering apparently was in progress in 1743, when La Condamine went down from Quito. The early Castilla industry carried the Peruvian name *caucho* eastward across Brazil, and later the Portuguese name for Hevea rubber, *borracha,* spread westward from Para. Even in Brazil it appears that Castilla was the principal source of rubber to the middle of the last century, only a few decades before Hevea was carried to the East Indies.

Pioneer plantings of Castilla in southern Mexico were dated as far back as 1867 by Olsson-Seffer, and still older planted trees were found around Pichucalco by Collins and Doyle. Larger Castilla projects were stimulated by developments with Hevea in the East Indies, before the radical differences in the latex systems of the two trees were appreciated. By 1908 more than a hundred thousand acres of Castilla had been planted in Mexico and Central America, which soon became a total loss, estimated at thirty to fifty million dollars. Interest in Castilla lapsed completely, leaving many plantations to grow up as forests, though some of these may yet serve in working out mechanical methods of separating the rubber from the bark and making the wood into paper or other by-products. Lumbering the logs to the mill may be the only labor required in Castilla forests, volunteer replacement being indicated by abundant undergrowth of seedling trees.

Planting of rubber reserves has been urged for economic and military reasons, and large denuded areas in southern Florida need to be reforested to reduce the fire and frost hazards. Castilla is an ornamental tree, better adapted than Hevea for growing in open places, shading out grass and mulching the soil surface. Even as a nurse-crop for Hevea, the planting of Castilla might prove worth while. Cuttings and seedlings grow rapidly, and hurricane hazards would be less than with Hevea, since the rubber of broken or uprooted trees could still be extracted.

O. F. COOK

BUREAU OF PLANT INDUSTRY
U. S. DEPARTMENT OF AGRICULTURE

ROOF FALLS IN MINES

AN investigation into the number of accidents resulting from roof falls in Pennsylvanian coal mines showed an annual distribution with maxima in the early spring and in the summer. The first maximum coincides with a high ground-water table in the overlying strata. The summer maximum occurs during those months in which the moisture contained in the ventilating air condenses in the mine because of lower temperature underground. The roof rocks expand under the influence of moisture, and it is suggested that this expansion gives rise to an increased number of roof falls, with the consequence of higher accident rates. The moisture expansion of rocks corresponds closely to the dangerousness of various types of roof rocks. Preliminary measurements gave the following linear expansions for rocks when wetted to saturation with water:

Brittle shale	3×10^{0}	per cent.
Solid shale	5×10^{-2}	" "
Sandy shale	1.2×10^{-2}	" "
Sandstone	9.7×10^{-3}	" "
Limestone	$< 1 \times 10^{-4}$	" "

H. LANDSBERG
J. B. MERRITT

GEOPHYSICAL LABORATORY
STATE COLLEGE, PA.

THE OLDEST AMERICAN FOSSIL ECHINOID

PROFESSOR HERMAN L. FAIRCHILD, of Rochester, N. Y., has brought to my attention a notice in the *Cornell Alumni News* (Vol. 37, No. 28, p. 2, May, 1935) concerning two specimens of *Lepidechinoides ithacensis,* purported to be the oldest fossil echinoids ever found in America. These were found in Devonian rocks in the vicinity of Ithaca, N. Y. An older specimen, *Koninckocidaris silurica* Jackson, dates from the Silurian. This fossil was found in 1908 by Professor A. W. Giles, who was at that time studying under Professor Fairchild. It was collected from the Rochester shale about 10 feet above the Irondequoit Limestone, in the Genesee ravine at Rochester, N. Y. The specimen shows an internal view of the dorsal portion

and according to Jackson[1] is "beautifully preserved. The holotype with two additional fragmentary pieces is in the collection of the University of Rochester, at Rochester, New York." To quote Professor Fairchild,[2] who also figured the specimen, "The fragment of the test or shell of a sea-urchin (Fig. 44) found in the ravine below Smith Street is the oldest echinoid as yet found in America." (Fig. 44 should read Fig. 45).

J. T. SANFORD

WICHITA FALLS, TEXAS

REPORTS

THE BANTING RESEARCH FOUNDATION

A RECENT report of The Banting Research Foundation shows that, in all, twenty-two different grants were distributed to workers in the laboratories of the universities throughout Canada during the year 1935–1936. A number of them were for comparatively small sums. For the first time in the history of the foundation a larger number of grants was made to workers in the University of Toronto than to other universities, and yet more grants were refused applicants in Toronto than in other universities. This is probably to be explained by the fact that the financial depression has perhaps affected the University of Toronto less than some of the other universities, though it has had the effect of increasing the number of well-qualified men who are unable to find posts and who consequently make application to the foundation to give them the means by which they can carry on their investigations. It is to be hoped that the raising of the depression will be followed by a more equitable distribution of the grants.

As a result of a grant made to Dr. A. C. Abbott and Dr. James Prendergast, of the University of Manitoba, the careful study of the effect of pregnancy on the state of the thyroid gland was published. The grant to A. J. Cipriani, of McGill University, was continued in order to enable him to complete his study of the methods of electrical recording of heart and respiration rates. The summer grant made to B. K. Coady and D. L. MacIntosh, of Dalhousie University, following small grants made in previous years, resulted in the publication with Professor Mainland of a series of four papers dealing with the character and counts of white blood cells with proper statistical analysis of their variation. The grant to K. A. Evelyn, of McGill University, was continued for another year in order to make clinical application of his method of photo-electrocolorimetry. The description of this apparatus has now been published and already various laboratories have adapted it for use, and there is no doubt that a valuable tool has been put in the hands of biochemical workers. Papers on the clinical application of the instrument are already in press.

A grant to Dr. L. Farber, of the University of Toronto, enabled him to make the preliminary steps in a study of the metabolism of certain of the infective bacteria. A grant to Dr. A. W. Ham, of the University of Toronto, enabled him to complete his study of the histological changes produced by chronic vitamin C deficient diet. This paper is ready for press. A grant to C. O. Hebb, of McGill University, resulted in a paper showing the relationship between external pancreatic secretion and the glucose content of the blood stream. A grant made to A. H. R. Smith, of the University of Toronto, led to a minor paper dealing with the anesthetic effects of some substituted furans and the development of a method of electrical recording of pulse pressure. Grants made to Professor L. Irving and K. M. Robertson, of the University of Toronto, enabled further progress to be made with the study of the effect of the carbon dioxide anhydrase, particularly in regard to the production of bone. The grant made to Dr. S. H. Jackson, of the University of Toronto, enabled a study to be made of the effect of skin infections on the glucose tolerance of animals fed both a high and a low carbohydrate diet. This material is also ready for press. A grant to Dr. E. M. Macdonald, of the University of Toronto, for the study of the transmission of immunity to the infant, is making progress. A grant to C. B. Stewart, of Dalhousie University, for a study of the accuracy of percussion has enabled him to gather a sufficient number of cases for a statistical study. A grant made to Dr. T. S. Perrett, of the University of Toronto, enabled further progress to be made on the effect of heparin on the prevention of thrombosis. A grant made to B. Schachter, of the University of Toronto, working under Professor G. F. Marrian, enabled them to publish a short paper on the oestrogenic substances in mares' urine, which shows that there is less variation in free and combined substances during pregnancy in this species than occurs in man. A grant made to Dr. M. C. Watson, of the University of Toronto, has led to the publication of the effects of sex hormones (supplied in part by Professor Marrian) on the disturbances of the menstrual cycle. A grant made to Dr. F. Smith, of McGill University, has led to the publication of a paper pointing

[1] Robert Tracy Jackson, Boston Society of Natural History, Mem. 7, pp. 285–6, 1912.

[2] Herman Leroy Fairchild, "Geologic Story of the Genesee Valley and Western New York." Published by the author. pp. 51–2, 1928.

out that strains of pneumococci exist which can grow under anaerobic conditions. A grant made to Dr. S. Weinstein, of the University of Toronto, led to the publication of a paper on the purification and assay of one of the sex hormones obtained from human urine during pregnancy. The grant to Dr. J. K. W. Ferguson, of the University of Western Ontario, for apparatus enabled him to complete a study of the carbamic compounds which are so important in the transport of carbon dioxide in the blood stream; a study of very considerable physiological importance. A small grant was made to Dr. M. J. Wilson, of the University of Toronto.

V. E. HENDERSON
D. T. FRASER
Honorary Secretaries

SPECIAL ARTICLES

NEW RECORDS IN HUMAN POWER

FIVE young men of international renown in distance running have been examined recently in this laboratory. In the group were: Lash, who within the past year has established new world's records in the 2-mile run, indoors and out; Cunningham, who holds world's records in the mile run, both indoors and out; San Romani and Venzke, milers on the U. S. Olympic team, who, with the fifth man, Fenske, have run the mile in near world's record time. All the men were in good running form at the time of the experiments.

Observations were made on the runners during rest and in four grades of work. The work of the first three grades was on a motor-driven treadmill: (1) a 15-minute walk at 5.6 kilometers per hour up an 8.6 per cent. grade; (2) a 5-minute run at 11.3 k.p.h. on the same grade; (3) a 5-minute run at 18.7 k.p.h. on a 4.0 per cent. grade. The fourth form of work was actual racing in an indoor track meet on February 13; five minutes after each man's race, venous blood was drawn for analyses.

The blood of these runners is like that of untrained man. The alkaline reserve, defined as the vols. per cent. of CO_2 in oxygenated blood at $pCO_2 = 40$ mm, averaged 48.1 as compared with 48.0 in a group of untrained men. The concentration of hemoglobin in blood and of proteins in plasma were within the limits observed in untrained man. The oxygen-combining capacity after the races ranged from 22.5 to 24.5 vols. per cent. in Cunningham, Venzke and Lash. The respective increases in the races were 7.6, 8.2 and 13.2 per cent. Each observed increase in oxygen capacity closely corresponds to the increase calculated from the observed change in plasma protein on the assumption that no protein leaves the circulation. The plasma chloride in rest and after races was normal, except for Lash, whose chloride shifted from 106.1 m.-eq. per liter in resting plasma to 99.0 after the race in which he broke the world's record for the 2-mile run. The races caused blood lactic acid to rise from 10, 16 and 9 mgm per cent. in rest to 116, 134 and 150, respectively, in Lash, Cunningham and Venzke.

The ratio $\frac{\text{residual air}}{\text{total lung volume}}$ averages 0.288 in the 5 runners and 0.285 in 11 non-athletic young men measured in this laboratory. The average vital capacities in the 2 groups are 5.36 and 4.74 liters, respectively. Expressed in liters per m of body height, the averages are 3.03 liters, ranging from 2.85 to 3.52, in the runners, and in the other group 2.73, ranging from 2.27 to 3.05. Hurtado[1] found an average of 2.72 liters per meter of height in 50 young men.

The maximum ventilation of San Romani, Venzke and Lash, the only runners who went through the hardest grade of work in the laboratory, averaged 113 liters per minute, as compared to 98 liters per minute of 99 other subjects in maximum work. The ratio $\frac{\text{tidal air}}{\text{vital capacity}}$ is practically the same in both groups, averaging 0.458 and 0.464, respectively. The greater ventilation in the runners was due principally to their average respiratory rate of 48, the rate of the untrained being 44. The tidal air of the runners was 2.38 liters with the untrained 2.25 liters. For a given oxygen intake the runners' ventilation was about 12 per cent. less than that of the other subjects.

In the walk at 5.6 k.p.h. the oxygen intake of the 5 runners averaged 1.0 liter per m² body surface and the blood lactic acid, 13.4 mgm per 100 cc blood; in 8 untrained young men the averages were 0.99 and 19.1. The similarity of oxygen intake means that in this sort of activity the efficiency is about equal, but the lower lactic acid level in the runners reflects their superiority of oxygen supply to tissues.

Oxygen intake and blood lactate in the harder grades of work are shown in Fig. 1. It will be noted that the runners adapted themselves quite readily to the speed by attaining relatively high oxygen intake. They kept the lactic acid at a fairly low level and finished the run with comparative ease. In this run all the untrained men were compelled to supply a considerable fraction of the energy anaerobically. Thus they accumulated more lactic acid, and only 2 were able to continue for the full 5 minutes. The measurements recorded in this run probably represent maxi-

[1] A. Hurtado and C. Boller, *Jour. Clin. Invest.*, 12: 793, 1933.

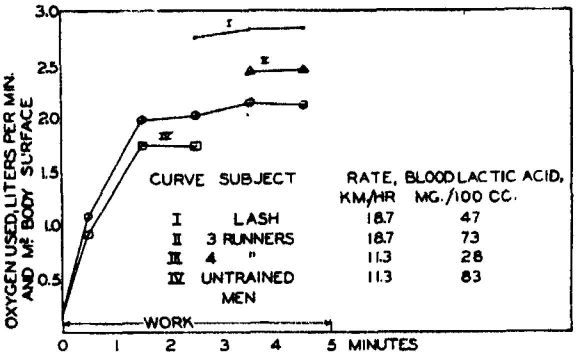

FIG. 1

mal levels of metabolism in all individuals except the runners. Skill is no doubt a factor in the easy adaptation of the runners, but since we did not measure oxygen debt we have no actual measurement of the total energy requirements of the men. When 3 of the runners ran for 5 minutes at 18.7 k.p.h., a task which brought lactic acid up to about the same level as that found in the other men in their maximal work, the runners in all cases elevated their oxygen intake even more, and in 2 of the cases probably reached their maximums. One of the most remarkable observations in the entire experiment was Lash's consumption of 4.96, 5.08 and 5.1 liters of oxygen successively in the last 3 minutes of this run and finishing with a blood lactic acid of only 47.5 mgm per cent. His highest R.Q. in this run was 0.99. In another experiment he reached an oxygen intake of 5.35 liters per minute in a run at 21.6 k.p.h. with no grade. This is approximately the same pace that he runs in his 2-mile race. If related to basal metabolism, this means that he elevated his metabolic rate to 21.4 times its basal level as compared to 14.5, the maximum of the best untrained man. This far exceeds previous records of a similar character, such as those of Henderson and Haggard[2] on Yale oarsmen, Christensen[3] on Danish cyclists and Hill[4] on Cornell runners. The high rate of oxygen intake which can be attained by these men is due largely to extremely high cardiac output, since their blood is normal in oxygen-carrying capacity.

The heart rates were recorded continuously throughout work and recovery by a cardiotachometer. The 5 runners performed the walk with an average pulse rate of 111 per minute, while the other men averaged 134. The average recovery is much quicker in the runners, dropping 34 beats to 77 in the first 30 seconds after stopping work, while at the same time in recovery the other group dropped 19 beats to 115. The next grade of work was hard enough to cause the untrained men to reach their maximum heart rates; they averaged 190, while the 4 runners who went through this run reached an average of 171. The hard work (not attempted by the untrained men) brought the blood lactic acid of the runners up to an average of 73 mgm per cent. and the average heart rate to 189, approximately the maximum of untrained man. The average heart rate for each group after the hardest work attempted is given in Fig. 2. Recovery took place at

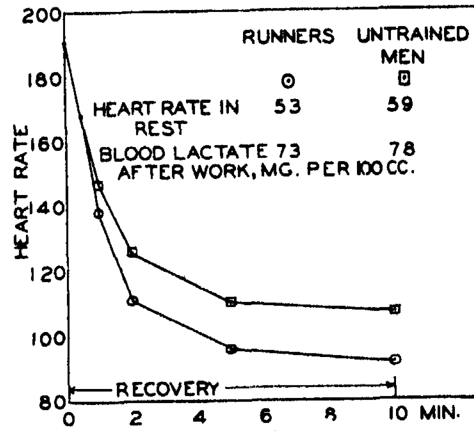

FIG. 2

the same rate in the first half-minute, after which the runners' pulse fell more rapidly.

S. ROBINSON
H. T. EDWARDS
D. B. DILL
THE FATIGUE LABORATORY, MORGAN HALL
HARVARD UNIVERSITY

THE DIFFERENTIATION OF PANCREATIC TRYPSINS ON THE BASIS OF THEIR SPECIFICITIES

PANCREATIC juice contains at least three enzymes (trypsin, chymotrypsin, heterotrypsin[1]) which are capable of degrading genuine proteins. Synthetic substrates have been obtained recently for each of these enzymes. Thus, chymotrypsin has been found to digest simple derivatives of tyrosine and phenylalanine such as carbobenzoxy-*l*-tyrosylglycine amide and carbobenzoxyglycyl-*l*-phenylalanylglycine amide.[1] The existence of heterotrypsin was discovered because of its ability to split benzoylglycyl-*l*-lysine amide. It has now been found that crystalline trypsin readily hydrolyzes α-benzoyl-*l*-arginine amide.

The accessibility of synthetic substrates, the structure of which may be modified almost at will, makes it possible to perform comparative studies of the specificities of the various trypsins. The following table indicates the wide differences in chemical speci-

[2] Y. Henderson and H. W. Haggard, *Am. Jour. Physiol.*, 72: 264, 1925.
[3] E. H. Christensen, *Arbeitsphysiol.*, 5: 463, 1931.
[4] A. V. Hill, "Muscular Movement in Man," McGraw-Hill, 1927.

[1] M. Bergmann and J. S. Fruton, *Jour. Biol. Chem.*, April, 1937.

TABLE I
HYDROLYSIS OF SYNTHETIC SUBSTRATES BY PANCREATIC TRYPSINS

Substrate	Crystalline trypsin	Crystalline chymotrypsin	Hetero-trypsin
Benzoylarginine amide ...	+	−	
Carbobenzoxytyrosylglycine amide	−	+	
Benzoylglycyllysine amide.	−	−	+

ficity among crystalline trypsin (Northrop), crystalline chymotrypsin (Northrop) and heterotrypsin.

It may be mentioned that the substrates of trypsin and heterotrypsin both contain basic amino acid groups; nevertheless, this basicity is in itself not decisive for the specificity, since trypsin does not split the substrate of heterotrypsin. It has been reported[2] that chymotrypsin attacks the highly basic protamines which are extremely rich in arginine. This is of interest, since the artificial substrates of chymotrypsin do not contain a basic group and since chymotrypsin is unable to split either of the synthetic basic substrates of heterotrypsin and trypsin.

With the aid of the synthetic substrates exact estimations of each of the trypsins in the presence of each other become possible and their respective activities in various biological systems may be determined. Such an investigation of commercial pancreatin showed that this enzyme preparation splits benzoylglycyllysine amide much more rapidly than benzoylarginine amide. Therefore, pancreatin must contain a large amount of heterotrypsin and the activity of pancreatin toward genuine proteins must, to a large degree, be due to heterotrypsin.

The physiological rôle of the pancreatic trypsins is generally considered to be one of preparing the food proteins for a complete breakdown. If this be the only physiological function of the trypsins, it is difficult to understand why they exhibit such pronounced and narrowly limited specificities.

MAX BERGMANN
JOSEPH S. FRUTON
HEINZ POLLOK
THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH
NEW YORK, N. Y.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

IGNEOUS ROCK TEXTURE DEMONSTRATION FOR STUDENTS OF ELEMENTARY GEOLOGY

THE study of igneous rocks by students of elementary geology is greatly facilitated by laboratory demonstration of the various types of texture, namely granitic, felsitic, porphyritic and glassy.

To demonstrate those textures in which either macroscopic or microscopic crystals are present to give a grained appearance to the rock, it is first necessary to prepare a supersaturate solution of sodium thiosulfate ($Na_2S_2O_3 \cdot 5\ H_2O$) by heating 100 cc tap water to boiling, then dissolving 200 grams sodium thiosulfate in the boiling water. The test-tube and its contents are cooled to or below room temperature by placing the test-tube and contents in cold running water. The cooled sodium thiosulfate solution is supersaturated.

For the formation of a granitic texture, place approximately 20 cc supersaturated sodium thiosulfate solution in a test-tube and inoculate the solution with a small particle of foreign material to start the crystallization. Crystals begun by the introduction of foreign material form aggregates which in arrangement of the individual crystals have the same arrangement as the crystals observed in igneous rocks of a granitoid texture.

The fine, almost microscopic, size crystals characteristic of felsitic textures may be obtained by violently shaking a test-tube containing 20 cc supersaturated sodium thiosulfate solution. The agitation of the supersaturated solution causes the formation of large numbers of minute crystals which accumulate on the bottom of the container. The crystalline character is distinctly seen when the accumulation at the bottom of the container is examined with a hand lens.

Two distinct sizes of crystals may be obtained in a single test-tube by first inoculating 20 cc supersaturated solution of sodium thiosulfate with a particle of foreign material and allowing the crystal aggregate to become well developed. The container with the developing crystal aggregate should be violently agitated by shaking so as to cause the formation of minute crystals, which in falling to the bottom of the container mix with the larger crystals of the aggregate to form porphyritic texture.

Glassy texture, such as is represented in obsidian, can be demonstrated by placing a 250 cc beaker half filled with granulated sugar over a Bunsen burner and heating slowly. The heating must be slow enough that the sugar melts without burning. If the melted sugar is poured into a beaker of cold water or on a cold surface, the resulting rapid cooling will form glassy textured masses.

The procedures mentioned above are not in themselves new but merely represent an application of elementary chemical and physical principles in experiments that can be conducted as classroom demonstrations to aid the student of elementary geology in

[2] E. Waldschmidt-Leitz and S. Akabori, *Z. physiol. Chem.*, 228: 224, 1934.

understanding the different textures found in igneous rocks and the relation of each to relative rates of cooling necessary to produce them.

W. FARRIN HOOVER

UNIVERSITY OF ILLINOIS

USE OF NILE BLUE SULFATE IN MARKING STARFISH[1]

THIS method was developed by the writer in the summer of 1935 and has been used very successfully for the past two years in his studies of the migration of starfish population of Long Island Sound and in connection with other problems where the marking of the individual starfish was desired.

The method consists in immersing living starfish in a solution of Nile Blue Sulfate for a short period of time. The solution is prepared in the following way: One gram of Nile Blue Sulfate is dissolved in a small volume of distilled water and then diluted with sea water to make up one liter of solution. If a large number of animals is to be stained at the same time, it is more convenient to prepare about 10 liters of solution at once. Dr. G. Gruebler and Co.'s Nile Blue Sulfate gives the best results.

When the solution is ready the starfish are placed in it. To avoid the suffocation of animals the solution should be aerated. The normal starfish (*A. forbesi* and *A. vulgaris*) are usually of orange-red color. After being placed in a freshly made solution of the dye, the animals acquire a very deep blue color in from 3 to 5 minutes, but as the solution weakens, longer immersion is necessary. According to my experience it is possible to stain several hundreds of medium-sized starfish, using one gram of the dye. The method can be used equally well for the marking of small or large starfish. Small, rapidly growing starfish, however, retain the color for considerably shorter periods than large ones. In the studies of the migration of starfish population of Long Island Sound, many large starfish were recovered 10 months after they had been stained and released in the Sound. At the end of the 10-month period the blue color was considerably faded but still quite deep.

In experimental work occasion often arises when each starfish has to be marked so as to be distinguishable from all other animals used in the same experiment. In such cases, the Nile Blue Sulfate method is indispensable because of the simplicity of its use. Any ray or any portion of the starfish's ray can be quickly stained by immersing it in the solution of Nile Blue Sulfate for several minutes. The stain is localized in the immersed part of the starfish and does not spread over the entire animal.

[1] Published with the permission of the U. S. Commissioner of Fisheries.

The simplicity and efficiency of this method is readily apparent if it is remembered that the self-mutilating tendencies of starfish prohibit the use of any other method of marking such as attachment of tags or cutting off portions of the rays.

VICTOR L. LOOSANOFF

MILFORD BIOLOGICAL LABORATORY
U. S. BUREAU OF FISHERIES

A PORTABLE HOOD FOR SMOKING KYMOGRAPH DRUMS

MODIFICATIONS of the apparatus described by Williams[1] in SCIENCE produced a portable hood which is fully effective at a cost of $7.00.

An end board of the proper dimensions was removed from a tight packing box, the dimensions of which were 27″ × 17″ × 16″. Over this aperture was placed an older model dismantled Hoover sweeper. A sheet of tinplate, 7½″ × 16″, was fastened across the top portion of the open side, and the box was entirely lined with tin. The original plan called for a hose through which the smoke could be expelled. Great was our satisfaction to find that the sweeper's sack would retain all carbon, even if benzene were used!

Increases of one or two inches in the above specifications should not adversely alter the effectiveness of the apparatus. Experience shows that decreases are not to be recommended.

The Hoover sweeper is peculiarly adapted to this work because of its wider suction opening. Sweeper companies resell used machines of the vintage in question, after reconditioning the motor, for $6.00.

EDGAR P. JONES

UNIVERSITY OF AKRON

[1] G. W. Williams, SCIENCE, 81: 2106, 465–466, 1935.

BOOKS RECEIVED

American Philosophical Society. *Memoirs*, Vol. VI, 1937, *Snowshoes*. By DANIEL S. DAVIDSON. Pp. x + 207. 65 figures. $2.50. *Memoirs*, Vol. VII, 1937, *Oklahoma Delaware Ceremonies, Feasts and Dances*. By FRANK G. SPECK. Pp. viii + 161. 4 figures, 4 plates. $2.00. *Transactions*, New Series, Vol. XXX, February, 1937, *Paleocene Faunas of the San Juan Basin, New Mexico*. By WILLIAM D. MATTHEW. Pp. viii + 510. 85 figures. 65 plates. $5.00. The Society, Philadelphia.

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SCIENCE

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THE PHILOSOPHY OF PHYSICS[1]

By Dr. W. V. HOUSTON

CALIFORNIA INSTITUTE OF TECHNOLOGY

IN appearing here to speak on the philosophy of physics I am in a rather dangerous position. Those of you who are philosophers will want to know by what right I speak on such a subject without having mastered the classical philosophies and without knowing the various traditional answers which have been given to the problems I shall discuss. On the other hand, physicists will accuse me of having left the austere and narrow path of physics to wander aimlessly, or at least uselessly, among the byways of philosophical verbiage. For most physicists have a traditional mistrust of philosophy. A definition of philosophy which usually provokes much self-satisfied mirth among physicists is as follows: Philosophy is the systematic misuse of a terminology especially invented for the purpose.

Yet in spite of this state of mind, the rapid changes in the concepts with which physics deals have almost forced some consideration by physicists of problems which were formerly regarded as belonging to the exclusive domain of philosophers. This consideration has been in the light of experimental results and because of this fact may be of value to the philosophers themselves. As a variation on the proverb that "Truth is stranger than fiction," may I suggest that experiment reveals stranger things than man's imagination has ever invented. Possibly some of the new results of experimental physics may reveal new aspects of old philosophical problems. Hence I propose to describe not so much any one unified philosophy of physics as a series of results of physics which I believe may have some bearing on philosophical problems.

One of the problems which has occupied the minds of philosophers is concerned with the nature of existence. Does there exist a material world, and can any-

[1] An address delivered in a series on "Outlooks in Philosophy" at the California Institute of Technology.

thing be learned about it? On the whole physicists have taken a very naive view of such matters. To my mind it has been this fact, this naiveté of view-point, which has contributed much to the successful development of physics.

When physics entered the experimental phase about the time of Galileo, troublesome questions of existence were ignored, and it was assumed, often without adequate consideration, to be sure, that there existed an outside material world which could be contacted through the senses. It was also assumed that these sense contacts could be reliably interpreted and that an observer could actually learn the nature of this outside world through his observations. To the scholars of Galileo's day this was not at all a self-evident proposition. It seems self-evident to some of us to-day because we have been brought up that way, but three hundred years ago people were apparently much more impressed with the possibility that things are not what they seem than with the simpler problem of at least seeing what they seem to be.

As is often the case with apparently simple statements, the simplicity becomes less obvious when the matter is considered more carefully. If one considers the statement that there exists an outside material world, the question arises, "what is it outside of?" Is it everything outside of the person who is speaking or is it outside of something else also? An active physicist rarely stopped or stops now to consider such a question. He is so busy observing things in this outside world that he has no time to bother about its strict delimitation, although he probably realizes instinctively that there must be a division somewhere between himself and this world which he is to observe. He is usually willing to admit that his hands and his feet belong to the outside world. He can apply to their movements the laws of mechanics, and he is willing to suppose that the physiological processes which go on in them can be objectively described. When he has a sore throat or a headache he is willing to consider himself as an onlooker observing these things. On the other hand, he certainly thinks of himself as something apart from these physiological phenomena, something in the nature of an observer who can watch the outside world go by. The naive view must also recognize the fact that there are other observers, and it assumes that they all see essentially the same things, and in fact can tell each other about them.

Thus I think that, largely without a formal organization of their thoughts, most physicists regard the world as made up of two kinds of things: (*a*) Physicists and, if pressed, other persons or potential physicists will be included in this select group, and (*b*) the outside material world which can be studied and discovered. It is true, of course, that there are variations on this division. There are those who in the attempt to be consistent will include all other persons in the group of things called the outside world, and others pushing still more firmly toward the apparently logical necessity will want to include themselves also in this outside world. I doubt, however, if these two latter groups are really motivated by the philosophy which they defend. I have heard psychologists complain of lack of sympathy from physicists in the attempt to apply the methods of physics to psychology, and I suspect that this lack of sympathy was due to the probably subconscious feeling that the psychologists were not properly recognizing this division of the world into two kinds of things and were getting themselves mixed up with the part of the world they wished to study.

Because of the simplicity of the physicist's attitude, the difficulties in his dualism were not at first troublesome. For instance, the question as to how a sensation got from the obviously material body of the observer to the obviously non-material observer himself was not a troublesome question: every one could see that the sensation did get across the boundary line, and so what more was there to be said about it? Nevertheless, a little consideration of this problem makes it very formidable. Although it may seem quite clear that there are two kinds of things, observers and the material world which is observed, a little consideration shows that not only the nature of the boundary between the two but even the location of this boundary is obscure. As far as the results of physical science are concerned it seems possible to put this boundary at almost any desired point. The observer can with apparent consistency include any desired amount of this outside world in what he may wish to call merely extensions of his senses. The part remaining beyond appears to follow the laws of physics in a perfectly satisfactory manner, and there exists in the laws of physics no reason for assuming the boundary to be one place rather than another.

Consider, for example, that I wish to observe this desk. I am on one end and the desk is on the other end of a chain of interactions. Where shall I draw the line between myself and the thing observed? In the first place, I can draw the line at the surface of the desk and say that the scattering of light from the surface constitutes the act of observing the desk. I can say that the source of light, the light itself, and all the mechanism necessary for the perception of the light is part of me, is an extension of my sense organs. On the other hand, I could also say that what I really observe is the light which strikes the retina of my eye, that this is the point at which the observation really takes place, and that here must be drawn the line dividing the observed things from myself. But I can go still farther and say that the action of the light

on the retina is a purely physical process which can be described by known laws and that the dividing line must be placed at a point at which the nerve impulse reaches the brain. The fact that none of these places seems satisfactory might suggest that there should be no dividing line at all, except for the uncomplicated feeling that there must be made some such division. On the other hand, no one of these interactions shows any characteristics which distinguish it from the others as long as only the classical physics is used, but one of the contributions which has come from the interpretation of the modern quantum mechanics is the recognition of the fact that, although the interaction which may be selected as the dividing line between observer and object is entirely arbitrary and may be put at any desired point, it is nevertheless necessary to put such a dividing line at some point and to treat the interaction at this point in a unique fashion. To make clear the nature of this difference may I outline briefly the method used in the quantum mechanical description of the behavior of an isolated part of the world.

According to the present theory, the state of a mechanical system is described or represented by a mathematical symbol which I shall call the wave function. This symbol carries all the information which can be known about the system in the particular state in which it is. This symbol changes with the time in accordance with a differential equation, known as the Schroedinger equation, in a perfectly definite way. If the state of the system is known at one time it can be predicted for any future time by means of this equation. In case the system is composed of two or more parts, the interactions and mutual influences of these parts are entirely described by this equation. But now suppose I want to examine the system. Suppose I want to see if everything is going on according to the rules, and for this purpose I want to make a measurement of some quantity which pertains to the system. As soon as I touch the system with a measuring instrument, as soon as I make any kind of contact with it sufficiently vigorous to learn anything about it, the symbolic wave function explodes in my face. The interaction between the system and myself in the form of a measuring instrument can not be made gentle enough to leave the system undisturbed and at the same time strong enough to give me some information; and this interaction can not be described by the same Schroedinger equation which described the behavior of the system as long as I did not touch it. The interaction with the observing instrument is subject only to the restriction of Heisenberg's principle of indetermination, which merely states that if the interaction is strong enough to do any good in the way of really making a measurement, it is so strong that the symbolic wave function which previously described the state of the system is no longer of any use.

On the other hand, if an observation of the right kind is made, it results in a knowledge of the state of the system after the measurement and the possibility of assigning to it the proper symbolic wave function. This state will then develop again in the manner prescribed by the equation of motion until another observer interferes with the orderly process. Thus there is a distinct difference in the treatment accorded interactions which take place within an isolated system itself and those which take place with the observer or the observer's extended senses in the form of measuring instruments, and it is just possible that this difference in treatment may be of significance beyond the regions in which it has thus far been applied.

One of the subjects often discussed in connection with the implications of physics is the problem of causality. One hears frequent statements about the principle of causality, the law of causality and more recently about the disappearance of causality from the world of science. The principal difficulty with this subject seems to be to find out what one is really talking about. It seems to be possible to make up a statement of causality which is true, *i.e.*, is in accordance with the observations, but which does not seem to be of much importance. It is also probably possible to make up a statement which seems to be of importance, but which is probably not true. But it is easiest of all to make a statement which sounds well but has no precise content whatever. Most of the few statements of causality which I have read belong to the latter class.

Apparently one of the essential elements of causality is that events shall have some connection in time, that the occurrence of a certain event now is necessarily followed by a certain other event at some later time. I do not mean that this is all that causality implies, but this seems to be at least one thing. However, it seems to me that the existence of some kind of a relationship of this nature is essential to the existence of a science, for the essential element of a science is that the known facts shall be classified. No body of facts, no matter how large or how well authenticated, can properly be called a science until these facts are brought under a suitable system. This system must certainly involve relations in time as well as in other ways, and so a kind of causality must be imposed if it is not already obvious, in order that there can be a science. Many of those subjects of study which aspire to be called sciences but which are not yet properly such, lack just this essential element. When a historian can read the papers to-day and tell what will happen to-morrow, then history will be a science, and no one will question the application of the term.

As I have already indicated, this causality, this uniform development in time, has been assigned in quantum mechanics to the symbolic wave function which describes the state of that part of the outside world under consideration. This symbolic wave function and its law of change carry within themselves the usual conservation laws, such as the conservation of energy, the conservation of momentum and the conservation of angular momentum. On these conservation laws rests the usual idea of determinism. The symbolic wave function does not carry, however, a detailed space-time description of the motions of the particles of which the mechanical system is composed. This wave function is quite an abstract thing. It can not be observed directly, and its connection with observations to be made on the system is, in general, only statistical. Thus it is true that the present mechanics does not permit an exact prediction of the result of a measurement to be performed to-morrow. It permits only statistical or probability predictions to be made in most cases.

Does this mean that there is no causality in physics? This still depends entirely upon what you mean by causality, upon what you want causality to do for you. To many persons the term causality is associated with the ideas of determinism and free-will, and the significance to be attached to the problem is because of its connection with ideas of moral responsibility.

At the time of the rapid development of Newtonian mechanics and its phenomenal success in describing and predicting the motions of the members of the solar system, there grew up the belief that all problems were to be solved by such essentially mechanical means. In particular it was concluded that our conscious mental processes were to be determined and described in terms of motions of atoms in our brains. Although this conclusion is clearly at variance with the simple dualism in terms of which physicists normally think, there were many persons who believed it to be a direct consequence of the thinking of physicists. The discovery of the statistical element in the predictions of quantum mechanics was seized upon by some as a means of escape from these unpleasant conclusions. It was suggested that although natural laws operate in all phenomena, they are not to be regarded as determinative, but merely as restrictive. Inside the range permitted by the statistical laws, free-will might be supposed to act.

In spite of this suggestion, I think it is now agreed by most physicists who have considered the matter that the conclusions from Newtonian mechanics to a materialistic determinism in phenomena of consciousness as well as the conclusion from quantum mechanics to a possible freedom of will are entirely without any justification in physics. In reaching such conclusions the naiveté of the physicist has over-reached itself and has produced a very superficial answer to a poorly understood problem.

Nevertheless, there has grown up under the influence of Bohr a recognition that certain aspects of the methods of quantum mechanics may provide a point of view useful in problems of this kind. As I have already indicated, the machinery of quantum mechanics provides for certain conservation laws, but does not at the same time provide a detailed space-time description of events. There are in the problems of atomic physics two complementary but mutually exclusive aspects, both of which are necessary to a complete description of the phenomena, but neither of which is adequate by itself. For instance, an electron is found to behave under certain circumstances as a wave, and under other circumstances to appear to have a clearly localized position as if it were a small particle. The achievement of the theory is in renouncing any attempt to describe one of these aspects in terms of the other or to establish any detailed connection between them, and in the recognition of this complementarity as fundamental. Certainly waves and particles are not the same thing; in fact, they are mutually exclusive things, and the recognition that in spite of this an electron has properties of both kinds is a real change in modes of thinking. In some such way one might imagine that problems of consciousness may have two complementary aspects. One of these aspects might suitably be described by such words as freedom of choice, while the other might be described in terms of physical or chemical reactions. The progress in understanding would come with the recognition that one of these descriptions does not exclude the other, but that they represent entirely different aspects of the problem. This rather surprising point of view which has been forced upon us by the results of actual experience may be one of the major contributions which physics has to make to philosophy.

May I now turn to another point. During the past fifty years much of the attention of physicists has been devoted to the structure of matter. Some twenty-five hundred years ago the philosophy of atomism was quite in favor, and it is now in favor again. The idea that all matter is made up of a few kinds of atoms was apparently recommended to the ancients as a method of getting some order into an apparently chaotic universe. Certainly until recently there was no more immediate reason for such a belief.

The essential idea of atomism is that the properties of matter can be explained in terms of relationships between elementary atoms. If this is to be done satisfactorily the atoms themselves must have very few and very simple properties, and it must be their combinations in various ways which produce the wide variety of phenomena which are observed. When the

atoms of the chemical elements were discovered well over a century ago they were moderately satisfactory in this respect. There were only a few varieties of them and their principal properties were a definite weight and a definite combining power. However, this simplicity did not last long. It became necessary to ascribe to the atoms themselves all sorts of special properties, and the study of atomic physics has led to the conception of a chemical atom as a very complex dynamic system. Nevertheless, the search for and the belief in ultimate indivisible atoms has gone on. At the present time there is again a small number of relatively simple atoms which one might call fundamental or ultimate. These are the positive and negative electrons, the proton, the neutron and possibly the neutrino. These are relatively simple. They each have a characteristic mass, a characteristic electric charge, and they each act on other particles with characteristic forces. In addition each of them appears to have a spin and a magnetic moment. Out of these basic atoms can be built, it is believed, all the varied and complex material world with which we are acquainted.

In so far as this can be done the picture is satisfactory. It looks as though the goal of the ancient atomists has been closely approached and statements have been heard to the effect that physics is finished, that there is nothing more left to do.

Usually when one is discussing indivisible atoms there comes along a cheerful soul who wants to know the structure of these ultimate atoms. He wants to know how big an electron is and what a proton is made of. The very asking of such a question is a denial of the fundamental nature of the particle in question. If a proton is really a fundamental atom there can not be anything smaller of which it can be made; there can not be any units in terms of which its size can be measured. As soon as it becomes necessary or desirable to talk about the structure of these ultimate particles their usefulness as ultimate particles is gone. It remains yet to be seen, of course, and will always remain to be seen experimentally, whether we shall have to have sub-electrons or sub-protons to explain how the electrons and protons work. Considerable effort has already been expended on the problem of the existence of an electrical charge smaller than that of an electron, but no such has been found. One can say that with the present experimental techniques an electron must always be taken whole.

However, the thing which I believe is of some general interest is that theoretical physics has developed methods for handling this kind of a situation. There have been adopted mathematical symbols and rules for interpreting them which describe the behavior of electrons and the other basic atoms in use. Within the framework of these rules there is at present no place for questions as to the structure of the particles involved. To the question how many electrons are there in this certain region the answer will always be one or two or three or some other integer. The theory is so built that the answer 1.5 can never be given. This is to my mind a real advance in the method of dealing with atoms. Whether it remains satisfactory can only be determined in the future, but the fact that it seems useful in a wide variety of fields suggests that possibly a limit is being approached in the process of subdividing matter, and that further subdivision may be unnecessary.

Thus far I have been discussing the results of physics which may have some bearing on philosophical problems. This should not be taken to imply that philosophers have ignored the results of physics. Such an implication would be far from the truth. As I have already stated, the remarkable successes of the mechanics of Newton were so impressive that various mechanistic philosophies were based on them. In this development the experimental physicists apparently played a secondary rôle. They seemed content to make their discoveries in the slow and laborious manner in which such discoveries must be made and to leave the generalizations to others. But the philosophers whose business it was to take a large scale view of things eagerly seized upon the laws of Newtonian mechanics as the long-sought-for ultimate and eternal truth. Upon the assumption that it would be possible in the future to discover suitable mechanical laws governing all phenomena, and with this assumption bolstered up by the successes of Newtonian mechanics, the advocates of materialistic and mechanistic philosophies wrote weighty tomes expounding their views. There developed at the same time, however, exponents of idealism or subjectivism who eagerly joined battle. I think that the apparently endless debates between opposing schools of philosophers have had much to do with the development of that distrust which most experimental scientists seem to feel for philosophy.

Curiously enough, this distrust of philosophy led in the latter part of the nineteenth century to another philosophy. It has been called a philosophy to end all philosophies, and it is designated by its proponents as the only true scientific view of the world. Although it has numerous opponents, it is more or less the official philosophy of physics to-day.

This philosophy designates as meaningless many of the questions ordinarily considered by philosophers. Only those problems are credited with significance which can be answered in terms of experiments or observations. This point of view has been called positivism.

The central feature of positivism is its insistence

upon empirical or experimental data as the only object of scientific study and its emphasis upon the descriptive feature of scientific theories. According to a positivist the object of a scientific theory is to classify and describe quantitatively and precisely the sensations which we experience. The use of the term "explain" in this connection is undesirable, because it carries with it connotations of some real world in terms of which the explanation is to be made and in terms of which things can be understood.

An extreme positivist tends to be a subjectivist. He denies the existence of a material world and will admit the reality only of sensations which it is his task to classify and describe. A more reasonable positivist says that the question as to the existence of an outside world has no meaning. It is impossible to give any satisfactory definition of the term existence except as a symbol by means of which experiences can be classified. A working physicist says, "I don't care whether there is an external world or not. It appears as though there were one and I can get results by assuming its existence."

The position of a positivist is a very strong one. He formulates the rules of the game so that any question which he can not answer can be declared to be meaningless. His point of view permits him to formulate satisfactorily such apparently irrational concepts as those of the theory of relativity and the quantum theory without talking so much about revolutions in physics as do the exponents of other philosophical systems. For these revolutions have not really been in physics but in the philosophies based on the physics. They have not disturbed the physicists so much as the philosophers. It is sometimes said that Einstein has superseded Newton and that the theory of relativity has eliminated Newtonian mechanics. If this were true our students might well demand their money back, for our hard-boiled faculty insists that they grind their noses on Newtonian mechanics for many long years. Furthermore, very few designers of machinery find it necessary to use Einstein's mechanics in writing their specifications. To a positivist this is all as it should be. The Newtonian mechanics was a means of classifying a certain set, and a very large set, of experiences. But when the Michelson-Morley experiment was performed, when the unexpected precession of the orbit of Mercury was established, when the bending of light around the sun was observed, it became necessary to adopt some wider, some more general scheme of classification which would include these additional facts as well. This was of course a revolution to those who had extrapolated Newtonian mechanics to cover all phenomena, but it was no revolution to a physicist and it would not perturb a positivist.

It is possible to illustrate the difficulties which a philosophy based on the existence of a real material world may have with the theory of relativity. According to this theory, which, it must be remembered, is merely an abstract statement of observed experimental facts, the length of an object depends upon its motion relative to the physicist who measures it. When measured by different observers moving relative to it with different velocities it appears to have different lengths. What, then, is the true length of the object? The theory of relativity and the positivist philosopher says it has no true length. One measurement is as good as another for determining the length, and the business of the theory is to state the connection between the different observations. The exponent of a real material world which is being discovered by means of the measurement will find himself in a difficult position. He can, it is true, say that length is not a fundamental attribute of objects in the real world but is a secondary quality such as color. When he does this, however, the suspicion keeps creeping in that it may be impossible to discover any attributes of the real world which are satisfactory in this sense.

In quantum mechanics the situation is even worse. The experiments on light have shown that at times light behaves as though it were a train of waves, while at other times it acts as a stream of corpuscles. The positivist is not displeased with this. He merely proceeds to build up a system of classification and description which will include all the observations, and after having built up such a system he is happy. His only further objective is to build a system of description which will include as many phenomena as possible, ultimately to include all phenomena. He would then have a complete philosophy. A philosopher of another persuasion, however, will want to know something of the nature of the reality behind this apparent paradox, and this desire will put him in a bad predicament, for waves and corpuscles are essentially different things. They have in fact mutually exclusive properties and as far as I know no one has yet been able to formulate an adequate picture of a reality to be behind these sensations.

As I have said, positivism is logically a very strong position. As far as I know, it is the only position completely tenable in the face of the experimental facts of relativity and quantum mechanics. Yet it is not without difficulties and has its strong opponents. In the first place, there is the usual difficulty with the position that all truth is sensation or experience. For different persons have different experiences and no two see alike. In order, then, to avoid a complete solipsism in which each philosopher is his own universe it is necessary to select in some way the experience which is more or less common to a number of observers. As soon, however, as this is done the whole

question of the real difference between those sensations on which different persons can agree and those on which they differ comes up and the problem is open again. So positivism seems to face the dangers of all subjective philosophies.

Positivism has also been attacked as a philosophy of resignation and defeat, as a refusal to admit the existence of problems for which no solution can immediately be seen. Fifty years ago the positivists denied the reality of atoms. Atoms, they said, are convenient means by which to describe the results of observation, but they are by their very nature such that it will be impossible ever to isolate and observe one. It has no sense to speak of their existence. Experience since then has not justified this position. Those who have made advances in physics have been those who took the atoms seriously, who went out and found methods by which individual atoms could really be observed, and if to-day a positivist still maintains that atoms and electrons are only useful fictions, he must admit that they are at least as useful and necessary as anything else whose reality he would affirm.

Thus while positivism is a philosophy which a physicist can easily defend, I am inclined to believe that it is not the philosophy which really motivates him. I am inclined to believe that those most effectively active in physics to-day have the very naive view which I mentioned at the beginning. They tend to believe that there is a real world which can be discovered, and they propose to discover it.

THE URSI PROGRAMS OF SHORT-WAVE STATION W1XAL

By Dr. A. E. KENNELLY

PROFESSOR EMERITUS OF HARVARD UNIVERSITY AND THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE Union Radio-Scientifique Internationale (abbreviation URSI), as its name indicates, is an International Union, founded in 1919 under the auspices of the International Research Council, for world study of radio science. It has sections in some twelve countries of the world and its Secretariat is at 54, Avenue des Arts, Brussels, Belgium. The Secretariat of the American Section is at the National Bureau of Standards, Washington, D. C. It has two official languages, French and English, for its reports, papers and discussions.

The URSI seeks to build up and to spread international knowledge of the scientific principles of radio communication and has held plenary meetings at two- or three-year intervals, the first in 1922, at Brussels, and later in Washington, D. C., London, Brussels and Copenhagen.

It was soon recognized that radio communication is affected by certain changes in cosmic phenomena such as (1) spots on the surface of the sun, (2) electric and magnetic disturbances on the earth, as well as in the upper regions of our atmosphere. In order to bring such cosmic changes promptly to the notice of radio observers in various parts of the world, the French Government in 1928, at the suggestion of the late General Ferrié, the founder and first president of the URSI, inaugurated a daily service of radio-cosmic bulletins, broadcast from the Eiffel Tower Station in Paris, which bulletins came to be known as Ursigrams. These Ursigrams, emitted in international dot-dash signals, were expressed in cipher code groups containing data of solar and terrestrial surface changes affecting radio. These messages, picked up in various countries by radio observers, and recorded by them in cipher code, were decoded into the languages of the various countries. Since 1929 these Eiffel Tower Ursigrams have been repeated daily in broadcasts from the long-wave radio station at Lafayette near Bordeaux and the shortwave station at Pontoise near Paris.

In 1929 the American Section of the URSI, recognizing the value of the Ursigram service in radio communication, enlisted the cooperation of a number of scientific institutions in America for the establishing of an American daily Ursigram service. These institutions have been the U. S. Coast and Geodetic Survey, the National Bureau of Standards at Washington, Smithsonian Institution, Carnegie Institution, Mount Wilson Observatory, assisted by the United States Government departments of Army, Navy and Weather Bureau.

Through the aid of Science Service at Washington, D. C., these institutions were enabled to collaborate for the emission of a daily Ursigram in international dot-dash signals from the U. S. Navy Station NAA at Arlington, Va., near Washington, D. C. Changes in the solar surface were reported from Mount Wilson Observatory; changes in the solar radiation intensity at the earth's surface were reported by the Smithsonian Institution; terrestrial magnetic observations by the Coast and Geodetic Survey; observations of aurora borealis in Alaska were supplied by the Car-

negie Institution; measurements of reflecting-layer heights and critical frequencies in the ionosphere by the National Bureau of Standards.

Since August 1, 1930, these observations have been forwarded daily to Science Service, Washington, by the aid of U. S. Army radio network. Science Service makes up a daily Ursigram in cipher code from the data received and forwards this to the U. S. Navy Department for the evening broadcast by U. S. Navy Station NAA. Additional cosmic data for the Ursigrams has been supplied by the Japanese Section of the URSI as well as from observers in the Philippine Islands.

The American Ursigram from NAA, broadcast every day of the year, has been of distinct service to radio operators in various countries by furnishing them advance information as to cosmic disturbances likely to interfere with radio communication. Until this year, however, all these Ursigrams have been carried by dot-dash signals of international Morse code. They can, therefore, only be received by persons trained as radio operators. The number of such radio-trained operators in the various countries of the world is naturally limited.

On February 1, 1937, short-wave station W1XAL at Boston, Mass., in liaison with Science Service at Washington, opened a daily URSI program by radio telephone in plain English, thereby supplementing to a much larger available audience of world listeners the coded Ursigrams.

W1XAL is a broadcasting station employing short-waves only. Its charter does not permit of broadcasting advertising or commercial information; its purpose being to disseminate cultural and educational information. It is supported by voluntary contributions, at present aided by a Rockefeller Foundation grant. The station operates with a power not exceeding 20 kilowatts on any one of four frequencies (6.04–11.79–15.25– and 21.46 Mc p.s., corresponding severally to wave-lengths 49.6 m 25.4 m–19.6 m and 13.9 m). The radio telephone broadcasts from this station have been reported as successfully received in practically all parts of the civilized world. The purpose of W1XAL is not only to disseminate cultural and educational information, but also to build and spread international understanding, cooperation, sympathy and good-will.

W1XAL seeks to interest a much larger number of scientific students around the world in telephonic Ursigram information than can be reached in the regular channels of dot-dash broadcasts through NAA. This change of vehicle from dot-dash signals to the spoken word introduces a new venture in scientific broadcasting. To English-speaking listeners everywhere the new W1XAL Ursigram broadcast should be as readily understood as any telephonic news broadcast, but to listeners in the various non-English-speaking countries it is desirable that the English language used be modified so as to be more readily understood; long and complicated words should, of course, be eliminated and the vocabulary employed should be as short and simple as may be practicable.

The Orthological Institute at 10, King's Parade, Cambridge, England, has promulgated for a number of years a simplified form of the English language, called "Basic English," suitable for verbal and written communications among elementary students of English in non-English-speaking countries. Basic English contains less than 1,000 selected English key-words, so that a non-English-speaking listener by learning the meanings of these words is able to understand communications in English which would otherwise be beyond his reach.

Basic English is now being officially taught in various European and Oriental countries as a secondary or international language, and more than fifty books have already been printed in Basic English for carrying this work into effect. It is generally admitted that Basic English not only furnishes a direct avenue for subsequent study of standard literary English, if desired, but also enables scientific information to be conveyed to a listener or reader with the minimum amount of linguistic effort on the part of both speakers and listeners. It frequently happens that an English-speaking reader opening for the first time a book printed in Basic English does not notice anything unusual about the text except what might be attributed to the literary style of the author. It would seem, therefore, that a good opportunity exists for increasing the number of world students interested in cosmic science and radio by the use of simplified English broadcasting at W1XAL.

The daily Ursigram Service of W1XAL has already been found suitable for swiftly conveying cosmic information, such as earthquakes and astronomical events of international significance, to all parts of the world. A few hours after W1XAL started its daily Ursigram service (21:55–22:00 world time, or GCT) an unexpected comet was recorded at Harvard College Observatory, Cambridge, U. S. A., on certain photographic plates of the northern sky. Dr. F. L. Whipple, of the Harvard Observatory, repeating and comparing similar plates on February 7, verified thereby the presence of a new small comet of the twelfth magnitude, in the Hunting Dogs constellation (Canes Venatici). Within a couple of hours of its official discovery at Cambridge Observatory the comet was reported in the daily Ursigram of W1XAL for world-wide distribution. This new comet on February 15 was at 35° 26′ North Declination and 13h 19m 30s

Right Ascension. This comet then had a tail of about one degree in length and it was traveling east and north about one third of a degree daily. It is estimated that this new comet (the first to be announced by URSI radio) will be closest to the sun and earth on June 22, 1937, at which date it is believed it will have attained the eighth or seventh magnitude, still too faint for the unaided eye but visible through a small telescope. Through the URSI announcement this new comet will probably have been under observation in many parts of the world and its discovery just after W1XAL opened the Ursigram broadcasts is a good augury.

The W1XAL URSI-broadcasts are emitted every day on a frequency of 11.79 Mc/sec. (wave-length 25.4 m) at 21:55–22:00 GCT, or 16:55–17:00 Eastern Standard Time (EST). The weekly URSI summary of cosmic events is being added every Monday, immediately after the daily URSI broadcast—*i.e.*, at 22:00 GCT so that, although the regular daily broadcast lasts only five minutes, the weekly broadcast on Monday may last twenty minutes or more.

SCIENTIFIC EVENTS

PRINCIPAL ADDRESSES AT THE DENVER MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

On Wednesday evening, June 23, the Maiben lecture of the American Association for the Advancement of Science will be delivered in Denver, Colorado, by Professor Nevil V. Sidgwick, F.R.S., of Lincoln College, Oxford, England. The association is particularly fortunate in securing this distinguished British scientist for one of its principal addresses. Dr. Sidgwick is not only eminent as a chemist but has rare personal qualities and an extensive acquaintance with America and American science. An American chemist, referring to Dr. Sidgwick, recently wrote:

> He has frequently been in the United States, in fact, has been fond of spending his holidays in the Rocky Mountains. He attended the Pittsburgh meeting of the American Chemical Society last September and I believe the Tercentenary at Harvard University as well.
>
> He is a kindly, lively and lovable gentleman who has made many friends among the chemists of the United States. . . . He has reached the apex of his achievements during the past ten years. . . .
>
> Dr. Sidgwick was the non-resident lecturer in chemistry at Cornell University in 1931 and in May of that year delivered the Edgar Fahs Smith birthday address in the Harrison Laboratory of the University of Pennsylvania, his subject at that time being "Atomic Cohesion," . . . .

It is interesting that Dr. Sidgwick "has been fond of spending his holidays in the Rocky Mountains," for the plans for the Denver meeting provide for a very attractive series of excursions into the magnificent Colorado mountains, the lower slopes of which in June are covered with flowers and the tops of which are white with snow.

On Tuesday evening, June 22, Dr. Herbert M. Evans, professor of biology and director of the Institute of Experimental Biology of the University of California, will deliver his address as retiring president of the Pacific Division of the association. The title of his address is, "The Development of Our Knowledge of Anterior Pituitary Function."

Dr. Evans was educated at the University of California, the Johns Hopkins University and Freiburg University, and he has been a member of the faculty of the Johns Hopkins University, as well as of the University of California. He has published many scientific papers and has been honored by membership in many scientific societies, including the National Academy of Sciences.

On Thursday evening, June 24, Dr. A. E. Douglass, professor of astronomy and director of the Steward Observatory of the University of Arizona, will deliver the John Wesley Powell lecture of the Southwestern Division of the association. The subject of his address is "Tree-rings and Chronology."

Dr. Douglass was educated at Trinity College, Connecticut, and at Harvard University. In addition to his contributions to astronomy, he has been a leader in extending chronology, particularly as it pertains to climatic variations, backward over long periods of time by studies of tree-rings. By this method, he has thrown much light on the climatic conditions surrounding prehistoric Indians of the Southwest.

It will be clear from these brief statements respecting the principal evening lectures at the Denver meeting that the association will present an unusually varied and interesting program, ranging from the fundamentals of chemistry to the remarkable functions of the anterior part of the pituitary gland, and to chronology as revealed by tree-rings. Together the lectures touch on an extraordinarily wide range of rapidly developing science.

F. R. MOULTON,
Permanent Secretary

THE AMERICAN CHEMICAL SOCIETY

At the North Carolina meeting of the American Chemical Society, President Edward R. Weidlein presented the following statement prepared by Dr. Charles

L. Parsons, secretary and business manager of the society:

The prosperity of the American Chemical Society and its usefulness to its members and to the country continues on an accelerating curve. The membership of the society is now slightly above 20,000, its goal as set for the end of the present year. Two thousand two hundred and eight new members have been added to the society from January 1 to date, making the total membership of the society 20,007. In spite of the increased number, 20 less members have resigned in 1937 to date than in the same period of 1936. Also the unpaid membership is 66 less than it was in the corresponding period of last year. Subscriptions to all the society's journals have notably increased, especially to *Industrial and Engineering Chemistry*. In the first three months of 1936 there had been an increase in subscribers to the industrial edition of *Industrial and Engineering Chemistry* of 942; in the first three months of 1937, there was an increase of 1,624 subscribers. The analytical edition had almost the same increases, but the news edition naturally increased more extensively, as it goes to all $9.00 paid members, whether they voluntarily otherwise subscribe or not. The subscriptions to the news edition as of April 1 was 21,617. There has been a good increase of advertising receipts, and an average increase of about 10 per cent. in the society's normal receipts from membership dues, subscriptions, sales of back numbers and miscellaneous.

The expenses, however, have been increasing out of proportion with the increase in membership, owing to the social security taxes and increased cost of paper and labor. New contracts have had to be signed covering these costs, and it would appear that increased costs of taxes, paper and labor have only begun. Owing to the increased membership, increased facilities of files, typewriters, safe and other equipment have become necessary, but it appears certain that the American Chemical Society again in 1937 will surely balance its budget. This is partly due to the fact that nearly a year's supply of paper was bought in advance, both for the society's normal publications and for the Third Decennial Index, and is in storage in Easton.

It is quite evident that in 1938 the society will have a larger percentage increase in its costs than it has to-day, or will have in 1937, owing to the advanced contracts, of which we have had immediate benefit.

The secretary is pleased to report to the directors that he has received contributions from the industry to the Third Decennial Index to date of $115,840 partly paid in advance. The society is bound by the proposition sent to the industry to offer to return to it any excess over $100,000, and this will shortly be done. A list of contributors, with amounts of those giving $300 or more, will soon be published in the news edition.

SYMPOSIUM ON THEORETICAL PHYSICS AT THE UNIVERSITY OF MICHIGAN

THE Symposium on Theoretical Physics at the University of Michigan, to be held between June 28 and August 20, will be devoted primarily to nuclear physics. To date the following lectures have been arranged:

Professor Enrico Fermi, Royal University of Rome: "Theory of Beta Disintegration"; "Neutrino Theory of Light." June 28 to July 17.

Professor C. E. Uhlenbeck, University of Utrecht: "Recent Problems in Statistical Mechanics with Applications to Nuclear Structure." Throughout the session.

Professor James Franck, the Johns Hopkins University: "The Physical Background of Photochemistry in Solutions with Application to Photosynthesis." During week of July 19.

Professor L. H. Thomas, the Ohio State University: "Numerical Solution of Wave Equations"; "The Normal State of the Nucleus of H^3"; "Collisions of Neutrons with Deutrons." July 23, 30 and August 6.

Professor Kasimir Fajans, University of Michigan: "Chemical Forces and Atomic Structure." Three weeks, beginning on July 26.

Dr. F. N. D. Kurie, University of California: "Beta and Gamma Radiation." June 28 to July 17.

The fifty-inch cyclotron and a million-volt high potential equipment which have been in active operation during the past year will be available for research during the summer. Those interested in this work should write early for particulars. In addition, the department offers numerous graduate courses and also facilities for research in many lines of theoretical and experimental physics. Holders of doctor's degrees may attend all sessions as guests of the university.

THE FINNEY-HOWELL RESEARCH FOUNDATION

A FOUNDATION for the study of cancer is provided for in the will of the late Dr. George Walker, head of the Out-patient Surgical Department of the Johns Hopkins Hospital, who died from cancer on March 31.

The foundation is called the Finney-Howell Research Foundation, in honor of Dr. J. M. T. Finney, emeritus professor of surgery at the Johns Hopkins University, and Dr. William H. Howell, emeritus professor of physiology, both of whom are placed on the board of the foundation under the terms of the will.

The primary object of the foundation is to provide a series of fellowships, each with an annual stipend of $2,000, for the study of cancer. Special grants may be made to support the work being done by the fellows. It will not have a laboratory or institute of its own. The money is to be spent entirely in supporting the work done by the fellows.

The principal must be expended within ten years. The fellowships will be annual appointments, but may be renewed for a period of three years. They are not limited to this country, but can be awarded to workers in institutions in any part of the world. It is stated that the available fund at the disposal of the founda-

tion will amount to $300,000, so that it will be possible to make awards of at least 15 fellowships each year for a period of ten years.

A meeting of the Board of Directors will be called soon to formulate announcements in regard to applications and awards and to make such regulations as may be thought necessary to initiate the work of the foundation.

Members of the board of scientific directors are: Dr. Philip Bard, Dr. Curtis F. Burnam, Dr. John M. T. Finney, Dr. William A. Fisher, Dr. Wade Hampton Frost, Dr. William H. Howell and Dr. Warren Lewis, of Baltimore; Dr. Evarts A. Graham, of St. Louis; Professor E. L. Kenneway, of London; Dr. Jonathan C. Meakins, of Montreal, and Dr. Florence Sabin, of New York. The financial directors of the foundation are: Jesse N. Bowen, Frederick G. Boyce, Jr., and Lee E. Daly, all of Baltimore.

THE AMERICAN PHILOSOPHICAL SOCIETY

AT the annual meeting of the American Philosophical Society, held at Philadelphia on April 22, 23 and 24, the following members were elected:

Class I—Mathematical and Physical Sciences: Eric Temple Bell, Pasadena, Calif.; Vannevar Bush, Belmont, Mass.; James Franck, Baltimore; Ernest Orlando Lawrence, Berkeley; Charles Edward Kenneth Mees, Rochester, N. Y.; Otto Struve, Williams Bay, Wis. *Foreign Nominee:* Werner Heisenberg, Leipzig.

Class II—Geological and Biological Sciences: Thomas Barbour, Cambridge; Henry Bryant Bigelow, Cambridge; Herbert Spencer Gasser, New York; Ralph Stayner Lillie, Chicago; William Pepper, Philadelphia; Alfred Marston Tozzer, Cambridge; Hans Zinsser, Boston. *Foreign Nominees:* Sir Frederick Gowland Hopkins, Cambridge; Hans Spemann, Freiburg.

Class III—Social Sciences: Herbert Eugene Bolton, Berkeley; Edmund Ezra Day, New York; Herbert Funk Goodrich, Philadelphia; Nathan W. Hayward, Philadelphia; Samuel Eliot Morison, Boston; George W. Norris, Philadelphia. *Foreign Nominees:* William E. Rappard, Geneva; Charles Rist, Paris; Harold William Vazeille Temperley, Cambridge.

Class IV—Humanities: William Scott Ferguson, Cambridge; Robert Frost, S. Shaftsbury, Vt.; Herbert Putnam, Washington, D. C.; Edward Sapir, New Haven; Preserved Smith, Ithaca, N. Y.; John S. P. Tatlock, Berkeley. *Foreign Nominees:* Charles Marie Joseph Bédier, Paris; Sir Frederic George Kenyon, London.

Officers reelected were: *President,* Roland S. Morris; *Vice-presidents,* Edwin G. Conklin, Robert A. Millikan and Henry H. Donaldson; *Secretaries,* John A. Miller and William E. Lingelbach; *Curator,* Albert P. Brubaker; *Treasurer,* Fidelity-Philadelphia Trust Company; *Executive officer,* Edwin G. Conklin. Luther P. Eisenhart, Alfred N. Richards, John M. Scott and Edward Capps were elected members of the council.

RECENT DEATHS

DR. LEROY WILEY MCCAY, from 1892 to 1928, when he retired with the title emeritus, professor of chemistry at Princeton University, died on April 13. He was seventy-nine years old.

DR. ROBERT HEYWOOD FERNALD, director of the department of mechanical engineering and dean of the Towne Scientific School at the University of Pennsylvania, died on April 24 at the age of sixty-six years.

DR. O. P. HOOD, who retired last June as chief of the technological branch of the Bureau of Mines, died on April 22. He was seventy-one years old.

DR. HARRY L. HALL, from 1925 to 1929 assistant professor of physiology at the Emory University School of Medicine, died on April 22 at the age of sixty-four years.

CHARLES T. AMES, for thirty-one years director of the Holly Springs, Miss., Experiment Station, died suddenly on April 18.

THE death at the age of seventy-three years is announced of Professor Paul Janet, director of the School of Electricity, Paris, formerly professor of physics in the University of Paris.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the celebration of Founders' Day on June 1 at the University of Manchester, the honorary degree of doctor of science will be conferred on Sir Henry Dale, Nobel Laureate, director of the National Institute for Medical Research, Hampstead. As previously announced, Sir Henry will address the Academy of Medicine of Washington, D. C., on May 8 and will give the eighth Harvey lecture of the current series at the New York Academy of Medicine on May 20. He will speak on the chemical transmission of the nerve impulse from nerve to muscle.

DR. WALTER E. GARREY, professor of physiology at the Vanderbilt University School of Medicine, was elected president of the American Physiological Society at the recent meeting at Memphis.

OFFICERS of the American Society for Pharmacology and Experimental Therapeutics have been elected as follows: *President,* Professor A. L. Tatum, the University of Wisconsin; *Vice-president,* Professor E. M. K. Geiling, the University of Chicago; *Secretary,* Dr. G. Philip Grabfield, Harvard Medical School; *Trea-*

surer, Professor Charles M. Gruber, Jefferson Medical College. Professor Paul D. Lamson, of the Vanderbilt University School of Medicine, was elected to succeed Professor E. K. Marshall, Jr., of the Johns Hopkins University, as editor of the journal of the society.

At the St. Louis meeting of the American College of Physicians Dr. William J. Kerr, professor of medicine in the School of Medicine of the University of California, San Francisco, was named president-elect, to serve in 1938–1939. President-elect Dr. James H. Means, of the Harvard Medical School, was inducted into office as president, succeeding Dr. Ernest B. Bradley, of Lexington, Ky. It was voted to hold the twenty-second annual convention next spring in New York City.

Dr. Ralph E. Cleland, professor of biology at Goucher College, is the first recipient of the John F. Lewis Award of the American Philosophical Society. The award, consisting of a diploma and the interest from a fund of $10,000, established by Mrs. Lewis, will be given annually for the "discovery of a truth in the field of knowledge deemed to be of real significance."

The John Phillips Memorial Medal of the American College of Physicians was presented to Dr. Richard E. Shope, of the Rockefeller Institute for Medical Research, at the St. Louis meeting. The medal was awarded to Dr. Shope for his research work on the virus which causes human influenza and its close relationship to influenza in swine.

The National Institute of Immigrant Welfare presented its annual awards to three "foreign-born citizens who have made significant contributions to American life," at a dinner in New York City on April 22. The recipients were Henry Morgenthau, Dr. Aleš Hrdlička and Dr. Leo Hendrik Baekeland. The award to Mr. Morgenthau was for his public service; to Dr. Hrdlička, curator of anthropology of the Smithsonian Institution, for his contributions to anthropology, and to Dr. Baekeland, "inventor of bakelite—a discoverer of resourcefulness and distinction," for his services to science.

The first Albert Ketcham annual award was conferred at the Chicago meeting of the American Society of Orthodontists on Dr. John V. Mershon, of Chicago, past-president of the society, who from 1916 to 1924 was head of the department of orthodontia at the University of Pennsylvania.

The Comet Medal of the Astronomical Society of the Pacific has been awarded to Leslie C. Peltier, of Delphos, Ohio, for his independent discovery of Wilk's comet on February 27.

The John Hunter Medal and Triennial Prize of the Royal College of Surgeons has been awarded to Laurence Frederick O'Shaughnessy, for his work on the surgery of the thorax.

Dr. Atherton Seidell, of the National Institute of Health, U. S. Public Health Service, has been promoted by the French Government from the rank of chevalier to that of officer of the Legion of Honor.

Dr. James Bryant Conant, president of Harvard University, has been elected to honorary membership in the Chemists' Club, New York, N. Y.

Dr. A. S. Eve, who retired two years ago as Macdonald professor of physics at McGill University, has been made president of the newly organized McGill Society of Great Britain.

Dr. Louis F. Fieser, associate professor of chemistry at Harvard University, has been promoted to a professorship.

Recent appointments of visiting professors at Yale University include: Dr. Robert H. Lowie, of the University of California, to serve as professor of anthropology for the first term of 1937–38; Dr. Charles G. Seligman, professor of anthropology at the London School of Economics, as Bishop Museum professor of anthropology for the second term, and Joseph W. Roe, of New York University, as professor of industrial management in the School of Engineering.

At the University of Cincinnati, Dr. Charles N. Moore, professor of mathematics, will fill the newly established position of director of graduate studies in mathematics; Dr. Louis Brand, professor of mathematics and head of the department of mathematics in the College of Engineering and Commerce, will be chairman of the combined departments of engineering and of mathematics in the College of Liberal Arts; Dr. Walter H. Bucher, professor of historical geology, will become chairman of the department of geology and geography, and Dr. Arthur G. Bills, since 1927 assistant professor of psychology at the University of Chicago, has been appointed professor of psychology and head of the department of psychology in the College of Liberal Arts.

Dr. John N. Swan, head of the department of chemistry at the University of Mississippi since 1915, having reached the age of seventy-five years, will retire at the close of the present academic year.

The Chemical Foundation, Inc., of New York City, has appropriated $5,000 in support of the research work of Dr. Ernest O. Lawrence, professor of physics at the University of California.

Dr. Philip Fox, director of the Adler Planetarium, has been elected director of the Museum of Science

and Industry, Chicago, to fill the position left vacant by the resignation of O. T. Kreusser, who recently joined the research staff of the General Motors Corporation.

MERRILL BERNARD, hydraulic engineer, has been appointed chief of the River and Flood Division of the U. S. Weather Bureau, to fill the vacancy caused by the death of M. W. Hayes. Mr. Bernard was with the U. S. Geological Survey from April, 1934, until June, 1935, on special hydrologic studies for the Mississippi Valley Committee, and with the Soil Conservation Service of the U. S. Department of Agriculture from December, 1935, until his transfer to the Weather Bureau.

DR. LIBERTY HYDE BAILEY, professor of agriculture emeritus at Cornell University and director of the Bailey Hortorium, has gone to Haiti, where he is making a collection of palms.

DR. HERBERT FRANCIS MARCO, of the U. S. Forest Service, is spending several months at the New York Botanical Garden doing laboratory research in connection with special studies in the breeding of forest trees, a work in which Dr. A. B. Stout is cooperating.

DR. ELSDON DEW and J. de Bruijne, of the South African Institute of Medical Research, left Johannesburg on April 6 to investigate blood groups among native tribes in the two Rhodesias, Nyasaland, Tanganyika, Kenya, the Anglo-Egyptian Sudan, Uganda and the Belgian Congo. They are traveling in a motor-caravan and will be away six months.

THE Edgar Fahs Smith Memorial Lecture will be given at the University of Pennsylvania by Dr. Charles H. Herty on Friday, May 21, at 8:15 P. M. He will speak on "Research the Guide for Sound Industrial Development."

DR. FREDERICK TILNEY, professor of neurology at Columbia University, will give the address at the annual initiation dinner of the Kappa Chapter of Sigma Xi at Columbia University on May 4. His subject will be "The Brain from Fish to Man."

DR. GEORGE H. A. CLOWES, director of research of the Lilly Laboratories, will give the eleventh annual series of Priestley lectures at the Pennsylvania State College from May 4 to 7. His subject will be "The Chemical and Physical Characteristics of Cell Structure and Function." The Priestley lectures, inaugurated in 1926 by members of the faculty of the School of Chemistry and Physics, constitute a memorial at Pennsylvania State College to Joseph Priestley. Since 1931 Phi Lambda Upsilon, honorary chemical fraternity, has cooperated in the presentation of the lecture series.

DR. LEO FROBENIUS, founder and president of the Institute for the Morphology of Culture at Frankfort-on-the-Main, will give a lecture at the American Museum of Natural History on May 5 at 8:15 P. M. He will speak on "Prehistoric Art in Africa."

JAMES A. G. REHN, curator of entomology and secretary of the Academy of Natural Sciences of Philadelphia, addressed the Lancaster Branch of the American Association for the Advancement of Science on April 29. The lecture was entitled "Hunting Animals in Africa."

DR. MADGE THURLOW MACKLIN, of the University of Western Ontario, gave on April 15 the Catherine Milligan McLane Lecture at Goucher College, Baltimore. Her subject was "The Inheritance of Disease and its Relation to the Practice of Medicine."

THE summer convention of the American Institute of Electrical Engineers will be held in Milwaukee from June 21 to 25.

THE annual meeting of the American Pharmaceutical Association and its affiliated groups will be held in New York City during the week of August 16.

THE twenty-fifth annual meeting of the Eugenics Research Association will be held at the American Museum of Natural History on June 5.

THE annual meeting of the board of trustees of the National Park Association will be held on May 14 at the Cosmos Club, Washington, D. C.

THE Museums Association of Great Britain will hold its annual meeting from July 5 to 9 at Newcastle-upon-Tyne.

THE annual report of the Brooklyn Botanic Garden for 1936 records an attendance of nearly 1,600,000—an increase of 200 per cent. over 1926; an attendance of more than 54,000 in visiting classes from schools (increase in ten years, 44 per cent.), and an attendance of more than 67,700 at other classes and lectures—an increase of 146 per cent. Twenty-four pages are devoted to research in progress during the year. Of the year's budget, 51 per cent. was provided from private funds income and 49 per cent. from the tax budget appropriation of New York City. For a number of years the trustees of the garden have provided 50 per cent. or more of the operating budget.

AT the twenty-fourth International Flower Show held in Grand Central Palace from March 15 to 20, the Brooklyn Botanic Garden installed an extensive exhibit of xerophytes, illustrating various ways in which plants meet the problem of drought. This exhibit included many plants from South Africa and various semi-arid regions. It was awarded the gold

medal and a special cash award, also an award of merit from the Garden Club of America. The Botanic Garden also exhibited four specimens, in flower, of the Devil's Tongue, *Amorphophallus* (*Hydrosme*) *Rivieri*. This exhibit, also, received a special award.

THE International Cancer Research Foundation has awarded to the School of Medicine of Temple University $6,000 to further the study started more than three years ago by Dr. Temple Fay, investigating the relationships between body segmental temperatures and the incidence of malignancy. Clinical observation has indicated that sub-normal temperatures and tissue refrigeration tend to inhibit abnormal cellular growth. The committee to administer this fund is composed of Dr. Temple Fay, professor and head of the departments of neurology and neurosurgery; Dr. Lawrence Weld Smith, professor of pathology, and Dr. William N. Parkinson, dean.

ANNOUNCEMENT of the gift of two telescopes which have been added to the equipment of the department of astronomy at Radcliffe College has been made by the trustees of the college. One is a photographic telescope made by Felker. The second is a Bausch and Lomb four-inch visual refractor. Both telescopes are mounted equatorially and have been erected in a small observatory on the roof of Byerly Hall, the science building where courses in elementary astronomy are conducted. Advanced students are privileged to use the facilities of the Harvard University Observatory.

THE Printing Industry Research Association has been founded in Great Britain for the purpose of supplying the trade with technical knowledge not only of type, paper and ink, but of the illustration processes most widely used—photo-engraving, lithography, photogravure. Bookbinding and box-making are also included. Printers vexed with problems arising from their work in any of these categories will be given specialist guidance on application to Patra House, the headquarters of the new association, which is maintained by the printing and allied trades in conjunction with the Government Department of Scientific and Industrial Research. The laboratories were opened by the Duke of Gloucester on March 9.

DISCUSSION

SEDIMENTATION IN A SMALL ARTIFICIAL LAKE

LAKES and reservoirs are often seriously affected by sediments which collect in them and which diminish their storage capacity. If erosion loss from the farms —sheet and gully wash—is not controlled, will sedimentation injure or destroy the work of the government in the great dams of the Muskingum Conservancy District and similar projects? If the water storage capacity of lakes and reservoirs is being seriously decreased by sedimentation, can this sedimentation be prevented or decreased? What factors are involved in the silting of reservoirs? These are some of the questions which may be raised in connection with observations of lake and reservoir silting. Obviously, the answer to these and other questions must be made from data collected from a number of different lakes and reservoirs. We, therefore, submit some observations taken in a small artificial lake in the hope that our observations, together with many other such observations, may prove of value.

On the campus of Muskingum College there is a small artificial lake, which has an area of about 40,750 square feet and a volume of about 410,000 cubic feet. In the fall of 1935 we made a study of the amount of silting which had taken place in the lake since its construction in 1915.

Before 1915 the site of the lake was occupied by two small streams which joined where the lake is now located. About 300 feet below the junction of these two streams an earth dam, 150 feet long and 75 feet wide at its base, was constructed across the valley. For a distance of 200 feet above the dam an area 150 feet wide was excavated for the purpose of forming a basin and in order to obtain earth for the dam. A vertical cement outlet which stands near the lateral center of the lake, 30 feet from the dam, has been provided to take care of the overflow.

As the lake was constructed it is an almost perfect settling basin; the only materials which escape are particles so fine that they do not settle out before the water goes over the outlet and material in solution.

A plane-table survey was made in order to obtain a map upon which the data were placed and from which the area of the lake was calculated. A silt rod was then used and the depth of the silt on the bed of the lake was determined as well as the depth of the water in the lake.

A mechanical analysis of the sediment was not undertaken, but note was made that where the two streams enter the lake the material was of visible shape, while farther from the streams the sediment was composed of fine material such as silt.

The coarser sediment was naturally deposited where the incoming streams dropped the heaviest portions of their load as their velocities were decreased upon entering the lake. While the total volume of this type of material is not as great as the volume of the finer materials the effect is more noticeable because of the concentration of the material near the mouths of the streams. At the mouth of one of the streams a delta

which contains about 17,236 cubic feet of sediments has been deposited since 1924. In 1934 a small island, composed of about 1,200 cubic feet of earth, was constructed as a nesting place for swans about 40 feet from the delta and directly in the path of the incoming stream. Since that date it has been connected to the delta by deposits of sediment, mostly shale and sandstone, the particles of which range from one half inch to two inches in diameter.

Beyond this coarse material a silt rod survey showed that the average thickness of the fine sediments which covered the bottom of the lake was 2.8 feet, while still farther from the incoming streams, near the dam, the average thickness was 2.4 feet. Computations of the total amount of sediment on the bed of the lake indicate that 102,800 cubic feet had been deposited between 1915 and 1935. In 20 years the water-holding capacity of the lake had been diminished 29 per cent. by silting. If we assume that the average weight of a cubic foot of silt is 100 pounds, this would mean that over 5,000 tons of silt have accumulated in this lake during the past 20 years.

There are several factors which have effected this deposition; the most influential one is probably the treatment of the farms and fields which drain into the lake. The water-shed is a small typical southeastern Ohio area of about 207 acres. This area was mapped in 1935 by the Soil Conservation Service as to soil erosion, slope and cover (cover meaning land use). Slightly less than half of the area is the property of Muskingum College and is used as college campus. This campus, from the standpoint of soil cover, may be considered as pasture, with the exception of a small area which is used as a baseball field and a small area of unpastured woodland. Approximately 12 acres of the water-shed are cultivated.

Most of the area is class 3 erosion.[1] In most of this particular area this would mean that from 4 to 7 inches of soil had gone down the streams and into the lake. There is one area of class 2 erosion, a small area in which we found from 6 to 8 inches of top-soil remaining. There are no serious gulleys in the area and only a few small places where the top-soil is entirely gone and the shaly sub-soil exposed. The soils of the area are all Muskingum soils, that is, residual soils of sandstone and shale origin, with the exception of a poorly drained flood plain of about one acre in area, which is Atkins silty clay loam.

In our analysis of the causes of deposition in the lake we found that construction work had probably been influential in affecting the sedimentation. Since the lake was constructed in 1915 a series of tennis courts, a baseball field and a football stadium have been constructed above the lake. All these have entailed extensive excavations and it is reasonable to believe that the process of sedimentation was greatly accelerated during these periods. However, we do not feel that the wash from these areas was the dominating influence in producing the sedimentation noted. The condition of the pasture fields, the campus and the cropped areas leads us to believe very strongly that sheet erosion and the small amount of gullying noted in the drainage area have had the greatest influence in producing the sediments which washed down the two small streams and settled in the lake.

R. H. MITCHELL
G. ROBERT HALL

MUSKINGUM COLLEGE

[1] Class 3 erosion is used to indicate land from which 25 to 75 per cent. of the top-soil is removed.

A NEW COLOR TYPE IN CABBAGE

"COLORED bud" is a brief descriptive name of a character found in an inbred line of cabbage in 1935 which to the writer's knowledge has not been previously described. Except for the light reddish purple color on the edge of the leaves of some plants, which may be the same as "sun color" previously described,[1] there is no external evidence that the terminal bud within the head is other than the usual white or pale cream in color. As the leaves are successively stripped away from the outside to the center, the leaf color is first green, then white (or cream) and finally pale pink or magenta.

The pinkish color is most intense on the edges of the small leaves surrounding the terminal bud and varies from 41B2 to 41C3 in terms of the "Dictionary of Color."[2] The color may be restricted to an area within one-half inch of the apex of the stem, or may extend over an area three inches in diameter surrounding the terminal bud. Upon exposure to light these colored leaves as well as the white ones soon develop a deep green color which obscures the other color.

The family in which this type first appeared comprised 84 colored and 32 white bud plants. Since the writer is unable to continue work with cabbage the remaining stock of seeds of this and related families is being sent to C. H. Myers, of Cornell University, for work on inheritance of colored bud and its relation to other color types. In correspondence dated November 2, 1936, Dr. Myers mentions the existence in his cultures of a type similar to the one described above.

This color type appeared in the third inbred generation from seed of a local variety of cabbage, purchased in the market place of Tashkent, Turkestan, U. S. S. R., by W. E. Whitehouse and introduced in the United States under number P.I. 82649 of the Division of Plant Exploration and Introduction of the

[1] Roy Magruder and C. H. Myers, *Jour. Agr. Res.*, 47: 233, 1933.

[2] A. Maerz and M. R. Paul, A Dictionary of Color, McGraw-Hill, New York, 1930.

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

ROY MAGRUDER
U. S. HORTICULTURAL FIELD STA.
BELTSVILLE, MARYLAND

MAGNESIUM SULFATE—A NEW INSECTICIDE

DR. V. R. HABER discovered the insecticidal properties of magnesium sulfate (Epsom salts) several years ago. His tests showed that $MgSO_4$ used as a spray, in the proper concentration, constitutes an effective control for the Mexican bean beetle (*Epilachna corrupta* Muls.). This spray has many advantages over arsenical sprays, in that it is easily applied, easily removed in preparing beans for cooking, and is harmless to humans if ingested.[1]

Hawkins, in a paper on the wheat wireworm (*Agriotes mancus* Say), finds magnesium sulfate and magnesium chloride toxic to this form.[2]

The following work on grasshopper control by $MgSO_4$ is the outgrowth of Dr. Haber's suggestion. Since there were neither time nor facilities to make complete tests, the results are only preliminary.

Grasshoppers, confined in small insect cages, four per cage, were fed with bran baits made of bran, molasses and water, with $MgSO_4$ added for test groups. The control groups received the bait with no poison, while others received a 5 per cent. arsenic bran bait. The test groups received the standard bait with 5 per cent., 10 per cent., 15 per cent., 20 per cent., 25 per cent. and 30 per cent. $MgSO_4$ added.

From comparisons of the mortality rates among the different groups, the following formula for a grasshopper bait is proposed:

Bran	60 per cent. to 65 per cent.
Molasses	15 " "
$MgSO_4$	20 " " to 25 " "
Water	Enough to moisten.

This formula seems to be just as effective as the 5 per cent. arsenic bait, it is cheaper, and it is absolutely harmless to humans, cattle, swine and poultry or other birds.

These results indicate that $MgSO_4$ may be an insecticide of value for the control of mandibulate insects. As a spray, it could be used safely on many vegetables and fruits, with little danger to humans and domesticated animals eating such foods. It is cheap, easily dissolved and should be compatible with other insecticides. Entomologists with facilities for testing $MgSO_4$ as an insecticide against mandibulate insects should attempt to determine its value in the control of such forms.

HUBERT W. FRINGS
MABLE S. FRINGS
UNIVERSITY OF OKLAHOMA

ANATOMICAL NOMENCLATURE

AT the annual meeting of the American Association of Anatomists, held at the University of Toronto on March 26, 1937, Professor C. M. Jackson, chairman of the Committee on Anatomical Nomenclature, made the following statement.

An account of the establishment of a permanent International Commission on Anatomical Nomenclature was published in the Anatomical Record, 1936, vol. 67, No. 1, pp. 1–6. This Commission adopted the NA system of nomenclature as the basis for revision, and requested that any desired changes be submitted before September, 1937. (The NA list was printed in the Anatomischer Anzeiger, Ergänzungsheft zum Band 81, 1936.)

Accordingly during the present year our American Committee has studied the question as to what changes should be proposed. Many difficult problems are involved. While the committee has not yet reached a final decision, it has agreed upon some questions of general policy. One is that in order to reconcile conflicting views it will be desirable for the present to use synonyms for some of the terms, as (for example) many of those of position and direction.

Any member of the Association may propose desired changes in the terms listed by the NA, and our committee would be glad to have these proposals for consideration. As the time is short, any such proposals should be submitted promptly, with reasons therefor. It is hoped that the final report of nomenclature with the recommended changes can be formulated in time to submit it to the Executive Committee of the Association for review and criticism before it goes to the International Commission.

GEORGE W. CORNER,
Secretary

SPECIAL ARTICLES

PHOSPHORESCENCE OF CELLS AND CELL PRODUCTS

A BODY which continues to give off light for a visually observable period of time after exposure to radiation is generally said to be *phosphorescent*.[1,2] Phosphorescence of inanimate systems has been studied rather extensively;[3] little attention, however, seems to have been paid to the phenomenon in cells and cell products. Thus while phosphorescence of tissues was

[1] Personal letter from Dr. V. R. Haber.

[2] J. H. Hawkins, Maine Agr. Exp. Sta., Bull. 381, 1936, p. 120.

[1] R. A. Morton, "Radiation in Chemistry," 1928.

[2] S. E. Sheppard, "Photo-chemistry," 1914.

[3] P. Pringsheim, "Fluorescenz und Phosphorescenz," 1928.

noticed as early as the eighteenth century by Becchari, who found that " . . . if a person shut up in a dark room puts one of his hands out into the sun's light for a short time and then retracts it, he will be able to see the hand distinctly and not the other"[4] no further study seems to have been made until 1933. In that year Hoshijima[5] found that human bones, teeth, cartilage, nails and dried tendons as well as certain abnormal calcifications would phosphoresce following irradiation with a Hanovia quartz mercury lamp, while a number of tissues did not.

To determine whether the property of phosphorescence is wide-spread, various materials of biological origin were irradiated, at one centimeter distance from the edge of the tube, for ten-second intervals, with a mercury-argon discharge tube (emitting radiations, of which some 85 per cent. are of 2537A),[6] and the life of visible phosphorescence was observed with the 20–30 minute dark-adapted eye and recorded. Three to nine trials were made with each object and three subjects took part in the studies. In all cases the afterglow can readily be observed, even if the period of irradiation is reduced to one second or less, but it is more difficult to compare the life of visible phosphorescence in many of the materials; therefore the longer period was used throughout.

It was found that while frog cornea, lens, stomach, kidney, muscle, blood and skin of the back showed no observable phosphorescence, the skin of the belly of the frog and the skin of the back as well as the palm of the human hand emitted light for two to four seconds after irradiation. All the tissue products studied showed phosphorescence. Chitinous material (Limulus exoskeleton), silicious material (glass sponge) and cellulose materials (wood, leaves and flowers of several kinds) showed short-lived phosphorescence. Horny materials, such as human finger nails, bird bills and feathers (pelican) and a spongin sponge phosphoresced for as long as ten seconds or more. Calcareous materials, such as bones, shells (of mollusks) and teeth showed very long-lived phosphorescence (20 to 25 seconds), and strangely enough bean seeds phosphoresced for almost as long a time. In general, it may be concluded that tissues show little or no phosphorescence, but compact tissue products may be highly phosphorescent.

Live human teeth showed about the same life of phosphorescence as did dead teeth from the same individual; apparently the living constituents of the teeth have little to do with the after-glow in this case.

[4] E. Darwin, "The Botanic Garden," p. 181, 1801.

[5] S. Hoshijima, *Sci. Pap. Inst. Phys. and Chem. Res. Tokyo* (*a*) 20: 109; (*b*) 21: 15 (1933).

[6] W. G. Leighton and P. A. Leighton, *Jour. Chem. Ed.*, 12: 139, 1935.

To determine which wave-lengths of light were effective in producing phosphorescence, several objects were irradiated with monochromatic light obtained by passing the radiations of a quartz mercury arc through a natural quartz monochromator. The intensity of the light was measured with a thermopile and galvanometer. The apparatus has been described in detail elsewhere.[7] The materials were irradiated and observed in the same manner as in the first set of experiments. It was found that very intense yellow light (5844A) excited no phosphorescence of teeth, bones and cotton, while blue (4350A) and violet (4050A) light of fair intensity induced just perceptible phosphorescence. All the ultra-violet wave-lengths tried excited phosphorescence, the shorter being most effective despite their low intensity; for while the intensities at λ's 3660, 3130, 3025, 2804, 2654 and 2537A were, respectively, 11.1, 8.5, 6.0, 1.0, 2.1 and 1.9 times the intensity at 2804A (12.54 ergs/sec./mm^2), the afterglow for the wave-lengths 3130 and shorter was 2 to 3 times that at 3660A for teeth and generally somewhat longer, when not markedly so, for cotton and bone. Thus the short ultra-violet is most effective, the long much less so and the visible region least effective in exciting phosphorescence in the objects tried.

There are two main groups of phosphorescent materials: (1) *organic materials*, such as dyes, of which Sheppard[8] says: " . . . all organic bodies possessing marked absorption bands in the ultra-violet seem capable of fluorescence in the dispersed medium or phosphorescence in a condensed condition, when excited by radiant energy of sufficient frequency"; (2) *inorganic salts*, such as the classic Lenard phosphors consisting of ZnS and CaS containing various metals as impurities. Some organic materials of biological origin such as starch and glucose, tested here, and gelatin, tested by Hoshijima,[9] even when chemically pure, show considerable phosphorescence. On the other hand, bone washed free of salts with HNO_3 is no longer phosphorescent.[10] In this case the inorganic salts are probably the phosphorescent agents. It is probable that both types of materials are responsible for biological phosphorescence, the constituent of greatest activity in any given case depending upon the composition of the material.

A. C. Giese
P. A. Leighton
Stanford University

[7] A. C. Giese and P. A. Leighton, *Jour. Gen. Phys.*, 18: 557, 1935.

[8] S. E. Sheppard, "Photo-chemistry," p. 413, 1914.

[9] S. Hoshijima, *Sci. Pap. Inst. Phys. and Chem. Res. Tokyo*, 20: 109, 1933.

[10] *Ibid.*

THE CHEMORECEPTORS OF CERTAIN DIPTEROUS LARVAE

IN spite of the frequency with which the larvae of such dipterous insects as the blow-flies are used in experimental work, the correct assignment of function to certain of their sense organs is seldom made. The most conspicuous of these organs are two pairs which are located in papillae on the oral lobes. Each organ consists of a compact group of cells connected by a relatively large nerve to the larval brain and communicating with the exterior at the end of the papilla. The first mention of these which has been found in the literature was made by Newport,[1] who, in a description of the larva of *Oestrus ovis*, called them "organs of vision." From their position and structure Weismann[2] later ascribed to them the sense of touch, and recently, in a study of the structure and development of *Drosophila*, Strasburger[3] holds this same view. In his monograph on *Calliphora* Lowne[4] speaks of them as "eye-like organs," and it is to his description that reference is most often made. Hewitt[5] states that they are the only obvious sense organs found on the larva of the house-fly, *Musca domestica*, and concludes, "Judging from their structure the organs appear to be of an optical nature, and this is the usual view which is held with regard to their function."

With few exceptions, notably Patten[6] and Crozier and Kropp,[7] most investigators who have used blow-fly larvae in studies of their responses to light have accepted these earlier decisions, based entirely on anatomical studies, that the organs on the oral lobes are the photoreceptors. The work of Pouchet[8] has been almost completely overlooked, and unfortunately so, since he showed in a series of simple convincing experiments that these organs in question could not be the only light receptors, for, when they were destroyed by cautery, the larvae still reacted normally to stimulation by light.

The experiments performed by Pouchet have been repeated on *Lucilia sericata* with similar results. These organs are certainly not the photoreceptors of blow-fly larvae. Are they organs of touch or do they serve some other function? The results of the following experiment answer this question. Three pairs of filter flasks were connected by way of their side arms and a piece of decaying meat placed in one member of each of two pairs. Larvae were introduced into the other member of a pair; the flasks were stoppered and left in the dark for one hour. A count was then made of the larvae in each of the flasks. Table 1 gives a summary of the results of five separate tests:

TABLE 1

	Normal larvae		Larvae with oral papillae removed		Normal larvae	
Flask	1	2	3	4	5	6
		(food)		(food)		
Distribution of larvae at beginning of tests	70	0	70	0	70	0
Distribution of larvae at the end of tests.	6	64	59	11	50	20

The great majority of the normal larvae passed from Flask 1 to Flask 2, presumably being attracted there by the odor from the meat. Only eleven of the seventy larvae with the receptors in question destroyed passed from Flask 3 to Flask 4, and this perhaps by chance, for in the control with normal larvae and no meat in the second flask twenty larvae wandered through the connecting passageway and were found in Flask 6, where there was nothing to attract them.

Thus it appears that at least one pair of the two pairs of sense organs on the oral lobes of *Lucilia sericata* is olfactory in function. There is some evidence from their structure that the two pairs do not serve the same purpose. The more dorsal ones have a central cavity with a valve-like structure guarding the opening of each to the exterior. The ventral organs are solid and the ends of the elongated sensory cells protrude through the opening in the papilla in such a manner that they may come in direct contact with the substrate. It is possible that the dorsal organs are olfactory and the ventral ones gustatory, although there is no experimental proof that this is the case.

The photoreceptors of blow-fly larvae remain to be identified. The cauterizing of various parts of the oral lobes and segments of the so-called "head" does not affect in any marked way the response to light. It is possible that the photoreceptors are scattered throughout the head region and that it is difficult to eliminate them all without serious injury to the larva. Viallanes[9] described and figured a complex network of nerve cells lying under the hypodermis of dipterous larvae, and in addition occasional groups of cells which he termed "peripheral ganglia." In cross sections of the anterior end of *Lucilia sericata* two clusters of sensory cells have been found, located one on either side of the prothorax. Their position is

[1] G. Newport, "Insecta." Todd's "Cyclopedia of Anatomy and Physiology," London, 1836–39.

[2] A. Weismann, *Zeitschr. f. wiss. Zool.*, 14: 187, 1864.

[3] E. H. Strasburger, "Drosophila melanogaster Meig, Eine Einfuhrung in den Bau und die Entwicklung." Julius Springer, Berlin, 1935.

[4] B. T. Lowne, "The Anatomy, Physiology, Morphology, and Development of the Blow-fly." Vol. I, R. H. Porter, London, 1890.

[5] G. G. Hewitt, *Quart. Jour. Micro. Sci.*, 52: 495, 1908.

[6] B. M. Patten, *Jour. Exp. Zool.*, 17: 213, 1914.

[7] W. J. Crozier and B. Kropp, *Jour. Gen. Physiol.*, 18: 743, 1935.

[8] G. Pouchet, *Rev. et Mag. de Zoöl.*, Sér. 2, 23: 129 and 225, 1871–72.

[9] H. Viallanes, *Ann. Sci. Nat. Zoöl.*, Sér. 6, 14: 1, 1882.

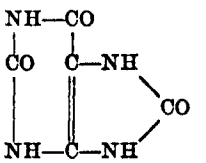
such that they might well be concerned with light reception, but carefully executed experiments will be necessary in order to make this matter certain.

John H. Welsh

Biological Laboratories
Harvard University

THE DISCOVERY AND IDENTIFICATION OF A NEW PURINE ALKALOID IN TEA

All the N-methyl derivatives of 2,6,8-trioxypurine I theoretically possible have been prepared synthetically, and we have to-day a very complete knowledge of their chemistry. Emil Fischer and Heinrich Biltz, with the collaboration of many coworkers, are the two investigators who have contributed the most to our present knowledge of the chemistry of these purines and their derivatives.



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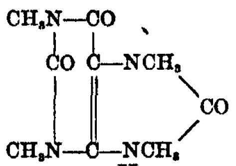

II

The occurrence of 2,6,8-trioxypurine as a product of purine catabolism in both the animal and plant kingdoms has been demonstrated conclusively, but, so far as the writer is aware, no N-methyl derivative of the purine I has, thus far, been shown to occur in nature. The author now presents this short note to report that the *tetramethyl-2,6,8-trioxypurine* represented by Formula II occurs in the mixture of purine alkaloids extracted from tea. It has been separated in a pure condition from such extracts, and has been shown to be identical with *1,3,7,9-tetramethyl-2,6,8-trioxypurine II* (tetramethyluric acid), which was first described by Emil Fischer[1] in 1884. Just as soon as proper and sufficient experimental material becomes available for the continuation of our plant extract researches, it is the intention of the author to search for this alkaloid and other N-methylated purines in the purine extracts of coffee and other plants. The results of this research program will be discussed in future papers to be presented for publication in the *Journal* of the American Chemical Society.

Treat B. Johnson

Yale University

[1] Emil Fischer, *Ber.* 17: 1784 (1884); also *Ber.* 30: 3009 (1897).

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CONDENSER DISCHARGE STIMULATOR FOR PHYSIOLOGICAL PURPOSES

The stimulator described in this report has been designed for the determination of the adequate shape and duration of current pulses used as stimuli on the cerebral motor cortex.[1] It has been found a useful device for general stimulation experiments wherever an attempt is made to gain more information about the excitable structures responsible for a certain effect. It also provides for a selective stimulation[2] in mixed peripheral nerves or in mixed tracts or centers within the central nervous system.

The set-up is based on the principle of condenser discharges adapted to the relatively low resistance of the tissue to be stimulated through a single-stage power amplifier.[3] It allows stimulation with alternating single or double condenser discharges whose duration, *i.e.*, time constant, can be changed over a wide time range (from .01 to 100 or 1000 milliseconds) without any change at all in the amplitude (peak intensity) of the discharges. The stimulating voltage, up to 10 or 20 volts, is led off from a potentiometer of 2,000 ohms maximum resistance. Any influence of the stimulating circuit upon the time constant of the condenser system is excluded.

From a source of potential A two condensers C and C^1 of different capacities are charged by make of K over two identical resistances R and R^1 to the same voltage, and they discharge over the same two resistances and a common resistance S, low in comparison with R and R^1, when K is opened. The resulting potential wave between x and y has its shape and direction determined by the ratio of one capacity to the other. It represents an ordinary condenser discharge if one condenser is disconnected, and a double condenser discharge (see[3]) if both condensers are placed in the circuit. Any such potential wave between x and y causes in the plate circuit of the amplifier tube AT (Cunningham 2A3) a current wave of identical shape. The resting plate current of AT is compensated by another similar tube CT with adjustable heater resistance. Equilibrium between the two tubes, *i.e.*, absence of potential between the ends of the potentiometer p, is controlled by a high resistance galvanometer v. Both halves of the potentiometer are divided into twenty intervals of 50 ohms each. Provided that the stimulating current is always led off from two symmetrical steps on the corresponding halves of the potentiometer, the current in the stimulating circuit is only due to, and directly pro-

[1] O. A. M. Wyss and S. Obrador, *Am. Jour. Physiol.*, in press (1937).
[2] O. A. M. Wyss, *Schweiz. Arch. f. Neur. u. Psych.*, 28: 210, 1932.
[3] *Idem.*, *Pflüger's Arch.*, 233: 754, 1934.

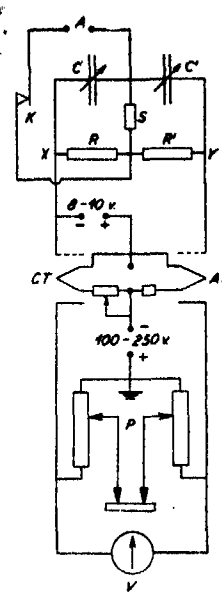

FIG. 1

portional to, changes in the plate current of AT; its shape, therefore, is that of the potential wave between x and y.

For double condenser discharges the most convenient ratio between C and C^1 has been found to be 2 to 1 (see[3]). The resulting peak potential between x and y reaches then 25 per cent. of the applied voltage A, whereas for single condenser discharges the full potential appears between these two points. Therefore, from a dry cell battery used in A, 36 volts were picked out for double condenser discharges and 9 volts for single condenser discharges. The condensers C and C^1 are variable from .001 to 1, or very slow current waves, 10 microfarads.[4] With two pairs of identical resistances for R and R^1, of 10,000 ohms and 100,000 ohms, respectively, a range of time constants as wide as 1 to 10^5 can be covered. The resistance S has to be kept as low as possible; a few hundred ohms are negligible, even with 10,000 ohms in R and R^1.

The duration of the single current pulse is determined (a) for single condenser discharges by the time constant: resistance $R \times$ capacity C, and (b) for double condenser discharges by the duration of the rising phase which is equal to $0.7 \times R \times C$, C being the greater capacity ($C = 2\ C^1$). The time values are obtained in seconds if R and C are expressed in ohms and farads, respectively. If, therefore, for R and R^1 two pairs of resistances of either 14,500 or 145,000 ohms are used, the duration of the rising phase of the double condenser discharge is directly given by the number of microfarads of the greater capacity, one microfarad corresponding to 10 or 100 milliseconds, respectively. The full wave duration is approximately five times the rising phase, which has to be considered if repetitive stimulation is used. In the latter case the ordinary contact key K has to be replaced by an automatic commutator.

[4] Decade condensers of General Ralio Company, Cambridge, Mass.

OSCAR A. M. WYSS

LABORATORY OF PHYSIOLOGY
YALE UNIVERSITY
SCHOOL OF MEDICINE

A METHOD FOR OBSERVING THE LOWER SURFACE OF SMALL OBJECTS

WHERE a simple device for examining the lower surface of small objects under the dissecting microscope is needed, a mirror may be used as a supplementary stage. The upper surface of the object can then be viewed by reflected light in the usual way, or by racking the microscope down twice the thickness of the mirror, the image of the lower surface of the object may be brought into focus. The object itself rarely causes any trouble while viewing the image; as, if the mirror is of adequate thickness, the object will be out of the line of vision and out of focus, often being entirely invisible. For the lower magnifications, where the objectives have a great depth of focus, the thickness of the mirror may need to be increased either by adding a supplementary glass plate or by raising the slide above the mirror on plasticene legs. This device, which no doubt has been repeatedly used, has several advantages, namely, the cheapness and availability of the material; the excellence of the illumination; and the speed and ease of changing views without the necessity of touching the slide or removing the hand from the focusing adjustment.

RALPH J. BAILEY

UNIVERSITY OF ARKANSAS
SCHOOL OF MEDICINE

BOOKS RECEIVED

American Mathematical Society Colloquium Publications, Vol. XXI. *Differential Systems* by JOSEPH M. THOMAS. Pp. ix + 119. The Society.

BLAIR, THOMAS A. *Weather Elements; A Text in Elementary Meteorology.* Pp. xv + 401. 107 figures. Prentice-Hall. \$5.00.

EMERSON, ALFRED E. and ELEANOR FISH. *Termite City.* Pp. 127. Illustrated. Rand, McNally. \$1.50.

Göteborgs Högskolas Årsskrift, XLII, 1936: 3. *Determinismus und Indeterminismus in der Modernen Physik; Historische und Systematische Studien zum Kausalproblem.* ERNST CASSIRER. Pp. xi + 265. Wettergren & Kerbers Förlag, Göteborg.

HICKMAN, CLEVELAND P. *Physiological Hygiene.* Pp. xxvi + 493. 89 figures. Prentice-Hall. \$3.25.

National Resources Committee, December, 1936. *Drainage Basin Problems and Programs.* Pp. viii + 540. U. S. Government Printing Office. \$1.50.

Olöstra Gåtor Aktuella Problem. Pp. 302. Illustrated. Wahlström & Widstrand, Stockholm.

Travaux et Memoires de l'Institut d'Ethnologie, XXIV. *Traité de langue amharique (Abyssinie).* Marcel Cohen. Pp. xv + 444. Institut d'Ethnologie, Paris.

SCIENCE

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MEDALS OF THE NATIONAL ACADEMY OF SCIENCES[1]

PRESENTATION OF THE JAMES CRAIG WATSON MEDAL TO ERNEST WILLIAM BROWN

THE problems of motion in the solar system have challenged the ingenuity of the greatest mathematicians and theoretical astronomers. Of those who have contributed to their solution none has attained the precision in representing the observed positions of the moon that Ernest W. Brown has achieved in his well-known theory. In 1907 he received the Gold Medal of the Royal Astronomical Society on the completion of the literal and numerical theory.

At that time about a dozen lunar theories had been produced. Of these that of Hansen held its place in the nautical almanacs. Before Brown's theory could replace that of Hansen it was necessary for him to make his theory accessible in the form of tables. The invention and testing of practical devices for this purpose engaged him for a number of years until the tables appeared in 1920. Hansen's approximate theory included 500 terms as against Brown's 1,500 terms. An ephemeris based on his theory would have required a hundred to two hundred hours' work for a single position. The numerical operations necessary for an hourly ephemeris extending over a year would demand at least a million hours of work. On the basis of a 40-hour week and a 50-week year, medical men would have to extend the span of life of a single computer to five hundred years to enable him to accomplish the task. With the aid of the tables the task can now be accomplished by a single computer in from six to nine months.

On the achievement of this second step in his lunar theory Dr. Brown was awarded the Bruce Gold Medal of the Astronomical Society of the Pacific. His tables have been uniformly used in the nautical almanacs since 1923 and predicted the 1923 eclipse with surprising accuracy. The honors which Brown has received were prompted not only by his lunar theory, although he had made it his principal task since 1890.

[1] Presented at the dinner of the academy, Washington, D. C., April 27, 1937.

Admirable accounts of his many other achievements were printed in the *Monthly Notices* of the Royal Astronomical Society and in the *Publications* of the Astronomical Society of the Pacific on the occasion of the award of the medals.

The third stage of his lunar theory, on which Brown is still engaged, has as its main objective the explanation of the minor discrepancies which have revealed themselves between the tabulated and the actual motion of the moon. At the same time his genius has conquered a variety of other hitherto unsolved problems based on Newton's law of gravitation. All these endeavors have led to new and significant results. The award of the Watson Medal therefore is based on his notable contributions to gravitational theory in general rather than on the specific achievement of the lunar theory.

In 1907 he had produced the most accurate value of the secular term in the moon's mean motion, but there remained unexplained well-marked deviations in the longitude of a fairly systematic character. There were also unexplained departures in the motion of the perigee and of the node of the moon's orbit amounting to the really small trifles of 17″ and −12″, respectively, per century. These he has practically wiped out by the inclusion of still further significant terms in his expansions. This last achievement was an unexpected by-product of a remarkable investigation on the stellar problem of three bodies, of which the third part on the motions of the apse and node, with applications to the moon, was published as recently as last December.

In 1924 he hit upon the real character of the occasional deviations in the longitude of the moon by correlating them with those of the sun and thereby was able to eliminate a gravitational cause external to the earth for the deviation of this type of the moon, sun, Mercury and Venus. This led to the discovery of the variability of the rotation of the earth and to the establishment of the moon as a more perfect timepiece than the earth. Of greatest importance are his demonstrations of the effect of the moon on the rate of the almost perfect Shortt clocks. At present he is engaged with Professor W. J. Eckert, of Columbia University, on a new numerical verification with the use of the modern computing machines.

Among his many other achievements, time permits me to mention only a few. He has produced a successful general theory of the Trojan group of minor planets which oscillate about the third corner of an equilateral triangle with sides equal to the distance of Jupiter from the sun. This theory is outstanding as regards originality and elegance of treatment and represents the observed motions of the planets of the group more perfectly than any other.

In the more general field of celestial mechanics he has made many significant contributions, including a general theory of resonance which he has applied successfully to the explanation of the gaps in the distribution of the mean motions of minor planets. His work on the Fourier series, on the development of the perturbative functions, his special forms of separate differential equations, which made it possible to integrate independently one class of terms irrespective of the others, and other contributions mark a new epoch in the general theory of perturbations. Here should also be mentioned his theory of the eighth satellite of Jupiter. And last, I must mention his conclusion that the discovery of the planet Pluto was not based on theoretical predictions, a conclusion which he reached after a highly ingenious and strictly mathematical discussion of the conditions of this remarkable case.

Such is a brief and wholly inadequate record of our medalist's achievements. The academy may justly be proud to count him among its members and to be able to honor him by the bestowal of the Watson Medal.

A. O. LEUSCHNER

UNIVERSITY OF CALIFORNIA

PRESENTATION OF THE HENRY DRAPER MEDAL TO C. E. KENNETH MEES

IN 1872 Dr. Henry Draper secured the first successful photograph of the spectrum of a star, and he also was first to secure any photographic record of a nebula . . . the great gaseous cloud in Orion. Thus we see he was a pioneer in the application of photography to astronomy and that he was possessed of an eagerness for improved means for observing the heavens.

Dr. Draper's brilliant pioneering work was unfortunately interrupted by his untimely death in 1882, before he was privileged more than a glimpse of the great advantages the application of photography was to bring to the study of the heavens. However, his widow, wishing to stimulate growth in this new field opened by her husband, established the Henry Draper fund with this academy, and indicated ways the income of the fund might be employed to stimulate study in this new field.

It then appears peculiarly fitting that the academy in this Henry Draper award is recognizing and encouraging the development of photography as applied to astronomy. And it is a pleasure to mention some of the grounds for the academy's awarding the Henry Draper Medal, this evening, to Dr. C. E. Kenneth Mees, director of the Research Laboratory of the Eastman Kodak Company, Rochester, N. Y.

Dr. Mees has devoted his life to the development of the theory and the perfection of photographic processes and materials. His early prominent piece of

work, "Investigations on the Theory of the Photographic Processes," published in 1907 in collaboration with Sheppard, has since been a classic on the subject. This gave him wide distinction, and he was called to America in 1912, where since then he has been continuously occupied in this field of endeavor at the Eastman Kodak Research Laboratory, of which he has been the director.

Let us recall that at the beginning of the present century it was hardly possible in astronomy to photograph a spectrum range of more than about 2,700 Angström units, *i.e.*, from 3,300–6,000 A. But to-day fully twice that length of spectrum (*i.e.*, from 6,000 to 12,000 A. in the infra-red) has been added. Much of this great gain has resulted from the development of emulsions and sensitizers at the hands of Dr. Mees.

Surely we would give enthusiastic welcome to a new telescope of double the power of any existing instrument, but would not astronomy gain far more if the power of our photographic plates were to be doubled, for such would in effect be doubling the power of *all* telescopes.

But Dr. Mees's wide extension of the photographable spectrum into the longer wave-lengths carries even greater scientific importance than might at once be evident, for it brings us knowledge of a vast new portion of the energy of the stars. And this means our knowledge of the heavenly bodies may now be builded upon this broader foundation. To point an example, the successful photography of the red and infra-red of the spectra of the planets has brought new knowledge of notable value on the constitution of the atmospheres of the planets.

In accomplishing these and other advances for photography our medalist has contributed to the general progress of science, as well as to astronomy in particular. Incidentally he has built up the excellent Research Laboratory of the Eastman Kodak Company. Thus for thirty years he has carried on with marked ability and skilful technique fundamental researches.

It is, therefore, a pleasure, on behalf of the Draper Committee, to present Dr. C. E. Kenneth Mees for the high honor of the Henry Draper Award.

FRANK SCHLESINGER
YALE OBSERVATORY

PRESENTATION OF THE AGASSIZ MEDAL TO MARTIN KNUDSEN

MARTIN KNUDSEN while a very young man had an experience that largely determined his scientific activities for the rest of his life. In 1895 and 1896 he undertook the physical investigations on board the Danish cruiser *Ingolf* in the seas around Iceland and Greenland. At the time of the first expedition Knudsen was 24 years old and he said, "I was totally unacquainted with hydrographical work, and the knowledge I had occasion to acquire of hydrographical literature before our departure in 1895 was but a trifle." During the first voyage he made observations on surface and subsurface temperatures, determined the specific gravity of water samples and the amount of chlorine in them, and took samples of water in bottles and in exhausted glass ampules. During the second voyage, as the water was immediately analyzed for contained gases, it was not necessary to collect samples in evacuated glass ampules. This program sounds simple, but there were difficulties. First, the thermometers for recording subsurface temperatures were inadequate—Knudsen thereupon improved the thermometers. He discarded as too crude the attempts to determine the specific gravity of sea water by means of hydrometers and further developed the method of chlorine titration. He also developed methods for making gas analyses on shipboard, so that the needed analyses were made immediately after the water samples were collected. The data presented in the tables and the discussion of the significance of the observations are based upon the more refined methods for procuring information. The range of problems discussed is most impressive. The "Hydrography of the *Ingolf* Expedition" by Knudsen is a classic contribution to oceanography. This was the accomplishment of a young man in his twenties. The *Ingolf* report was published in 1899.

Progress in many branches of science depends upon the possession of adequate instruments, a body of established physical constants and proper procedure. The mere recognition of a scientific problem will not solve that problem. Knudsen's first oceanographic experience made him keenly conscious of the fundamental needs of physical oceanography, and he set about the development of apparatus and the determination of physical constants. His invention of standard sea water and his refinements of chlorine titration for the determination of the salinity and density of sea water over the entire range of temperatures encountered in the ocean, and the tables prepared by him to embody the results of long-continued investigations, constitute a foundation stone of modern dynamical oceanography. The tools provided by Knudsen are necessary for utilizing the equations formulated and developed by V. Bjerknes, Helland Hansen, Sverdrup, Hesselberg and others for solving problems in dynamical oceanography. This statement also applies to the numerous graphical methods of treating oceanographic data.

Knudsen has made a number of designs of oceanographic apparatus, such as a frameless water-bottle, a bottom-samples for hard bottoms and a spectro-

photometer. He has also paid fruitful attention to a number of oceanographic problems. His first papers were on the influence of plankton on the quantities of oxygen and carbonic acid dissolved in sea water. His researches in the field of low pressure phenomena in gases are better known to physicists than to oceanographers.

In addition to his activities already mentioned, Knudsen has since 1902 rendered invaluable service as a consultant in hydrographical investigations for the Danish Government and the International Council for the Exploration of the Sea.

The members of the committee that nominated Professor Knudsen for the Agassiz Medal are happy that the academy approved its recommendation. Professor Knudsen richly deserves the honor conferred upon him.

T. WAYLAND VAUGHAN

WASHINGTON, D. C.

PRESENTATION OF THE MARY CLARK THOMPSON MEDAL TO AMADEUS WILLIAM GRABAU

THE Committee on the Mary Clark Thompson Fund, meeting in 1936, decided unanimously to award the medal provided for in this fund "for most important services to geology and paleontology" to Amadeus William Grabau, professor of paleontology in the National University of China and chief paleontologist to the Chinese Geological Survey. Among the recipients of this medal since 1924, chiefly paleontologists, are C. D. Walcott, E. de Margerie, J. M. Clarke, J. Perrin Smith, W. B. Scott, E. O. Ulrich, David White, F. A. Bather and, in 1934, Charles Schuchert.

The committee noted the distinguished services of Professor Grabau in general and stratigraphic geology, in the science of non-metallic mineral deposits and particularly in paleontology. His paleontological researches cover the Paleozoic of New York and during the last seventeen years the paleontology of China. The results of this work are contained in a splendid series of monographs on Chinese Paleozoic and also Mesozoic fossils, the last volume of which was published like the rest by the Academia Sinica, in Peking.

Professor Grabau was born in Wisconsin in 1870. He studied first in the Massachusetts Institute of Technology, where he served as instructor from 1892 to 1897. After obtaining his Sc.D. at Harvard in 1900 he served as adjunct professor at Columbia University, 1902–1905, then as professor from 1905 to 1919. In 1920 he was appointed to the two important positions in China mentioned in the first paragraph of this address, and he has remained there for the last seventeen years working unceasingly and most successfully on the paleontology and geology of China. His contributions are fundamental and exhaustive. And this in spite of severe physical handicaps during later years which would have discouraged any man with less courage and energy. Among his characteristics are an indomitable nature; a faculty of inspiring others with his enthusiasm; an ability to plan and carry out the work to which he has devoted his life.

The work of Professor Grabau is incorporated in a long series of publications. In 1910 he published in collaboration with another distinguished paleontologist, Professor H. W. Shimer, of the Massachusetts Institute of Technology, a widely used book on "North American Index Fossils." Later came "Succession of Faunas in the Middle Devonian in U.S.A."; the "Hamilton Fauna of Michigan"; "The Phylogeny of Invertebrates, Chiefly Gastropods"; "Principles of Stratigraphy" (second edition in 1921); "Textbook of Geology," 2 volumes, 1921; "Nonmetallic Deposits," 2 volumes, 1922; "Ordovician Fossils of North China," 1921; "Stratigraphy of China," 1925; and last but not least the succession of volumes referred to above and published by the Academia Sinica under the general heading, "Paleontologia Sinica." Besides these there are a great number of shorter papers. Enough of an accomplishment, one might say; enough to fill a long life.

I feel sure you will agree with me that in presenting this medal we are paying a just tribute to a most distinguished paleontologist and geologist who has brought honor to American geology to the four corners of the earth.

We regret deeply that Professor Grabau is unable to be here in person, but rejoice that we may entrust the medal to Mrs. Grabau, who is here with us to-night and who will transmit the token to Professor Grabau with our admiring regards.

WALDEMAR LINDGREN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ABSTRACTS OF PAPERS PRESENTED AT THE WASHINGTON MEETING OF THE NATIONAL ACADEMY OF SCIENCES

A catalogue of neurohumors: G. H. PARKER. Neurohumors are hormones produced by the secretory portions of the nervous system or by glands immediately associated with this system and serving as means of activating other parts of the nervous system and its effectors, such as muscles, glands, chromatophores and the like. Neurohumors are well illustrated by adrenalin, a secretion of the adrenal gland, and by intermedin, a product of the

intermediate lobe of the pituitary gland. Both these neurohumors act on the vertebrate melanophores of the integument, adrenalin causing these color cells to concentrate their pigment, intermedin to disperse it. In fishes such as the catfish the melanophore pigment disperses not only to intermedin, but also to a neurohumor from the melanophore nerve terminals. This pigment probably concentrates to a blood-borne neurohumor like adrenalin, perhaps adrenalin itself, and to a neurohumor from a second series of nerve terminals. Thus four sets of neurohumors are concerned with the activities of the melanophores in the catfish, two dispersing and two concentrating. Those from obvious glands are soluble in water and carried by the blood. Hence they have been termed hydrohumors. Those from the nerve terminals are insoluble in water but soluble in ether or oil, hence lipohumors. Hydrohumors are general in action, lipohumors local in action. Beside the four neurohumors acting on melanophores, there is in some fishes like the killifish an additional and independent set of neurohumors acting on the yellow cells or xanthophores. Thus in the chromatophore system there must be many kinds of neurohumors. When these many neurohumors are added to those such as acetylcholin, sympathin, and so forth, from other parts of the nervous system, it is seen that neurohumors, contrary to the older view, are an extremely diverse and numerous set of substance.

Pinocytosis—Drinking by cells: WARREN H. LEWIS. Normal macrophages and many malignant cells when cultivated outside the body thrust out thin active wavy ruffle pseudopodia which entrap and fuse around portions of the surrounding fluid and enclose them as globules within the cell. The globules move centrally, the contents are digested and the fluid then diffuses out of the cell. In the course of a few hours a cell may drink several times its volume of fluid. In this manner cells take in complex substances in solution such as proteins which can not diffuse into them. The macrophages, which come from the large mononuclear white blood cells, are scattered in the tissue spaces throughout the body in enormous numbers. We have been familiar for many years with the rôle they play as phagocytes; they ingest and digest dead cells and other debris such as occur in black and blue spots. As pinocytes (drinking cells) they probably play a still more important rôle, namely, the maintenance of the body fluids in proper condition, for there is good evidence that within the body they are continually drinking in, digesting and thus modifying the tissue fluids which bathe most of the cells of the body.

Hereditary vulnerability to dietary defects in the development of bone: G. L. STREETER, E. A. PARK and DEBORAH JACKSON. At the end of the first month, when their bone development is most active, young rats can be weaned and placed on any desired diet. After a sufficient period of test diet, if one wishes to study the effect of that diet on growth of bone, one can make x-ray films of a selected bone area and record the progress of its development. The animals in our experiments, after being subjected for three weeks to a rachitic diet and then x-rayed, were returned to a normal diet and reared, uninjured by the experience. Four months later they were bred. The breeders were chosen on the basis of the x-ray record of their sensitivity to the diet. Following fourteen generations of such selection and inbreeding, two strains of rats have been developed which in all appearances are alike, save in the one character that one of them reacts more severely to a rachitic diet (vitamin-D-free, high calcium and low phosphate) than the other strain. These experiments reveal the plastic nature of the growth line (epiphysis) of bones and its sensitivity to disturbances in the chemical composition of the body fluids. They also support those investigators who claim that heredity is a definite etiological factor in abnormal bone development, of the type seen in rickets. From such experiments we can thus understand why under equally unfavorable conditions the children in some families acquire rickets, while others do not.

The distribution of gene frequencies in populations: SEWALL WRIGHT. (To be printed in SCIENCE.)

Immunity and reinfection in experimental poliomyelitis: SIMON FLEXNER. As experience has grown, it has become apparent that the two immune states in poliomyelitis (infantile paralysis), one based on recovery from an attack of the disease and the other symptomless reaction to virus injections (vaccination), are not identical. They do agree in that under both sets of conditions antibodies usually appear in the blood; they differ in that symptomless immunization is less protective against reinoculation of the virus than is the state of resistance which develops upon a symptomatic infection. That reinfection called second attack does occur is established for children and even for monkeys, although this phenomenon has been given little attention. The study to be reported is based on a considerable number of monkeys which have recovered from attacks of poliomyelitis experimentally induced. The virus employed for reinoculation was always instilled into the nose. Several kinds of virus, derived from epidemics of infantile paralysis occurring in the years 1909 to 1935, were employed for these experiments. Attention was paid to the occurrence of distinct immunological strains among these specimens of virus used for reinfection. Certain conclusions have been reached as a result of the studies which may be stated briefly as follows: Monkeys which have recovered from an attack of experimental poliomyelitis are subject to reinfection by the nasal route. Second attacks of the disease result from inoculation with the specimen of virus used to produce the first attack and with specimens of different origin. Reinfection takes place in monkeys which have recovered from mild and from severe attacks and in convalescent animals which have been subjected to hyperimmunization. The two-year quiet period proposed by Still to separate relapses from second attacks, judging from the monkey, is probably excessive. Until greater attention is given the reinfections of varying intensities in man, conclusions on this point must be wholly tentative.

Experimental menstruation: GEORGE W. CORNER (introduced by George H. Whipple). It has long been known that menstruation is dependent upon the ovaries. Since the identification of the two ovarian hormones, oestrin

(the "female sex hormone") and progestin (the corpus luteum hormone) a number of observations have been made which hint that the menstrual phenomena may ultimately be explained in terms of the action of these two hormones upon the uterus. In a castrate monkey, for example, the cessation of a course of oestrin injections causes menstruation-like bleeding (E. Allen), and menstruation has therefore been tentatively explained as due to cyclic fluctuations in oestrin level. Oestrin (in moderate, presumably physiological dosage) does not, however, inhibit, in intact monkeys, an expected menstrual flow (Corner), but progestin does inhibit menstruation (Corner) and also oestrin-deprivation bleeding (Engle, Smith and Shelesnyak; Hisaw). Moreover, measurements of the oestrin content of the blood in women have not certainly revealed a correlation between menstrual bleeding and variations of the oestrin level (Fluhmann). In the experiments now to be reported, castrate monkeys receiving injections of oestrin (100 or 125 international units) were also given, after a suitable control period, one mg pure progesterone daily for 10 days. Menstruation-like bleeding occurred four or five days after cessation of the progesterone, in spite of the continued oestrin treatment. Elevation of the oestrin dosage to 500 international units did not completely prevent bleeding after progesterone under these conditions. Quantitative experiments designed to explain the mechanism of this effect are now in progress. The experiments point to a possible explanation of the menstrual bleeding of the uterus (in ovulatory cycles, at least) as the result of alternating presence and absence of the corpus luteum hormone, without the necessity of postulating cyclic variations in oestrin level.

Body fat as a factor in heat production: FRANCIS G. BENEDICT and ROBERT C. LEE. It has been commonly believed that body fat is metabolically inert. Experiments on geese and mice at the Nutrition Laboratory, however, indicate that body fat plays a rôle in metabolism. The geese were adults and the differences in size represented, chiefly, differences in fat content, for little protein is added to the body when adult geese are fattened. The total heat production was greater the larger the goose and in nearly direct proportion to the increase in weight. The heat production per unit of weight was essentially the same with geese weighing from 4.5 to 7.5 kg, although it has usually been found that the larger the animal species the lower is the heat production per unit of weight. Comparisons were also made of the basal metabolism and the body composition of the 20-gm albino mouse, the 60-gm fat mouse and the 8-gm dwarf mouse. Per unit of surface area the metabolism of the fat mouse is nearly twice as great as that of the dwarf mouse and 15 per cent. greater than that of the albino. Although the fat mouse weighs three times as much and has twelve times as much body fat as the albino, both have nearly the same amounts of body nitrogen. Yet the total daily heat production and the heat production per gram of dry protein of the fat mouse is more than double that of the albino. That body fat increases the energy production is, therefore, undeniable. The obese must pay in calories for their fat loads.

Sympatho-mimetic influence of deuterium oxide[1]*:* HENRY GRAY BARBOUR (introduced by Yandell Henderson). The mammalian body is over two thirds water. Substitution of one half the water by the recently discovered heavy water (deuterium oxide) is incompatible with life. When, however, the body water is but one fifth saturated with heavy water a mouse survives, but lives at a faster rate; that is, metabolism is increased by some 20 per cent. or more, usually with some elevation in body temperature. These effects appear due to excessive stimulation of sympathetic nerve mechanisms (sympatho-mimetic action). More definitely, sympathetic stimulation by heavy water can be shown in the pilomotor (hair raising) and exophthalmic (pop-eye) mechanisms of mice. When one fifth saturated they not only become rough-furred and pop-eyed, but these effects can be abolished almost immediately by ergotoxine, an alkaloid specifically depressant to the sympathetic system. Fish resort to protective camouflage in light surroundings by turning themselves pale. This is done by the sympatho-mimetic effect of light acting through the eye to cause contraction of the dark pigment in the melanophores. Heavy water also contracts melanophores but not after ergotoxine. One can mimic all the above effects, on metabolism, temperature, fur, eyes and skin, by injecting epinephrine, one of the sympatho-mimetic emergency hormones, secreted by the adrenal glands to prepare the body for fight or flight. Heavy water reinforces the natural substance epinephrine. Possibly it exhibits its sympatho-mimetic influence by delaying the disappearance of the natural hormone from the body. The details are described elsewhere in respective co-authorship with Drs. Bogdanovitch and Herrmann and Misses Trace and Rice.

The effects of alcohol as influenced by blood sugar: HOWARD W. HAGGARD and LEON A. GREENBERG. (To be printed in SCIENCE.)

Embryonic induction in regenerating tissue: OSCAR E. SCHOTTÉ (introduced by Ross G. Harrison). Previous experiments presented at last year's meeting of the Zoologists at Atlantic City have shown that the mesenchyme of regenerating extremities of Amphibia is totipotent, since typical lenses have been obtained by transplantation of this tissue on eyes of adults previously deprived of their lenses. In order to further test the potencies of this mesenchyme, embryonic eye-cups of *Rana pipiens* (stage 28 or 29, Harrison) have been transplanted below the skin of regenerating tails of large tadpoles. These eye-cups not only induced the regenerating mesenchyme to differentiate into typical lenses, but also induced in every case a complete redifferentiation of the surrounding cells. The loose mesenchyme now becomes a dense mass of cells, numerous mitotic figures occur, and eventually the differentiation of organs not connected with eyes can be observed: olfactory capsules, ear vesicles and even mouth cavities appear in the midst of the tadpole tail. This unusual effect of typical embryonic inductors is tentatively explained by the spreading of correlated morphogenetic fields, a process quite different from that

[1] These investigations are supported by the research funds of the Yale University School of Medicine.

which occurs in normal development. In the embryo, a spatially closed system, the differentiation of the available materials blocks any further action of "organizers," for which only a limited amount of cell material is available. In this new process of induction in regenerates, on the contrary, far more generalized effects are obtained because proliferation secures a continuous supply of fresh, undifferentiated cells. After the cells in the midst of which the inductor has been implanted become differentiated into new organs, they in turn serve as inductors to the proliferating mesenchyme. Other facts have shown that morphogenetic fields continue to be active throughout life, and now the above experiments suggest that proliferating mesenchyme embodies properties of indifferentiation similar to those of the embryonic ectoderm of amphibians before gastrulation.

On the evaporation from the oceans: H. U. SVERDRUP (introduced by T. Wayland Vaughan). The water which evaporates from the oceans is equal to the amount of water vapor which is transported upwards from the sea surface by processes of molecular diffusion and by eddy conductivity. Turbulence research in laboratories has led to a semi-theoretical expression for the eddy conductivity of air flowing over a rough surface and to a simple law for the variation of velocity with increasing distance from the surface. Observations of wind velocity at various levels have shown that this law is qualitatively valid over the sea. The same law is valid when dealing with the humidity, except that then it is necessary to assume the existence of a thin layer near the surface through which transport of water vapor takes place by diffusion. The thickness of this layer was found to be inversely proportional to the wind velocity, decreasing from 0.75 cm at a wind velocity of 1 m per second to 0.075 cm at a wind velocity of 10 m per second. Supposing that above this layer the eddy conductivity has the value which follows from the laboratory experiments and that the numerical constants which have been determined by such experiments can be applied, the amount of water vapor which is transported upwards can be computed if the wind velocity, temperature and humidity are known at one level and if the surface temperature of the water has been observed. From the Atlantic Ocean average meteorological data and corresponding average values of the evaporation are available. The values of the evaporation which have been computed by means of the meteorological data, making use of the above-mentioned assumptions, agree very well with the observed values. It seems, therefore, possible that by means of this procedure the evaporation can be computed under any given meteorological conditions.

How deep do ocean currents flow: COLUMBUS ISELIN (introduced by Henry B. Bigelow). At the present time physical oceanographers are in sharp disagreement as to what depths should be assigned to the lower boundaries of the major ocean currents. The older point of view is that while velocity decreases gradually with depth, some flow parallels the surface movements down to at least 2,000 meters. The newer conflicting theory is that the layer having a minimum oxygen content is also nearly motionless, and for all practical purposes marks the lower limit of the surface currents. Since the axis of the layer having the least oxygen is found at depths of only 300 to 400 meters near the equator and nowhere is deeper than 900 meters, all attempts to calculate the volume or velocity of ocean currents give very different results, depending on which of the above theories the particular investigator favors. Unfortunately as yet little conclusive evidence is available to support either view. The significance of this controversy in the case of the Gulf Stream and the Northern Equatorial Current is described and several arguments advanced that indicate that the older idea of relatively deep ocean currents should by no means be thrown into the discard.

Plankton and radiolarian ooze in Paleozoic formations of New York: RUDOLF RUEDEMANN. The plankton consists principally of the graptolites and associated organisms that were connected with the Sargasso-seas of the Atlantic Ocean and were carried into the great Appalachian geosyncline that extended from Newfoundland to beyond Alabama, at such times when it was open to the ocean currents. The associated organisms are principally small sponges, very primitive brachiopods and crustaceans. Other planktonic organisms of later Ordovician, Silurian and Devonian periods will also be shown. The Radiolarian faunas have been discovered in thick chert beds, associated with the graptolite shales. Nearly all the chert beds contain radiolarians and nothing else save occasional sponge spicules and graptolites. Some beds are entirely composed of radiolarians and these are compared to the "radiolarite" of the Alps and East Indies, which is considered as fossilized "radiolarian ooze." The fauna consists almost entirely of genera still living to-day and some of them are not found above 12,000 feet in the present oceans. The conclusion is therefore reached that the radiolarian chert represents radiolarian ooze formed at a depth corresponding to that at which the ooze is formed to-day and that the bottom of the Appalachian geosyncline sank at times to such abyssal depths.

Random Waring's theorems: NORBERT WIENER and NORMAN LEVINSON. It is well known and has been proved by Hilbert that every number is the sum of at most a finite number of kth powers of integers. There is reason to suspect that the vital part of this theorem concerns not the number-theoretic nature of the terms n^k but their manner of growth. The present paper is devoted to the proof that if λ_n is chosen at random between zero and n^k, in almost every case almost every integer can be represented as the sum of $k+1$ such numbers, and in almost every case there will exist a set of integers of density greater than zero which need $k+1$ such numbers for their representation. Similar theorems are proved for random selections not among all integers of a given range but among all integers of certain specified sets lying in a given range.

Trihornometry: A new chapter in geometry: EDWARD KASNER. A trihorn is defined as the combination of three curves C_1, C_2, C_3 passing through a common point in a common direction. The three horn angles are C_1C_2, C_2C_3,

C_3C_1. The three curves are represented by three points P_1, P_2, P_3 in an auxiliary plane; thus the trihorn is represented by a triangle. The conformal invariants then correspond to the three sides M_{ij}, and the three angles σ_{ij} of the triangle in a new metric where distance is defined by $(x_2-x_1)^2/(y_2-y_1)$. Neither equilateral nor equiangular triangles exist in the new geometry. The sides obey a certain inequality, and the angles a certain equality. If two sides are equal, the opposite angles are never equal; but the sum of the opposite angles is unity. In general any three of the six parts of a triangle (except the three angles) determine the other three, but sometimes two distinct solutions exist. Two triangles with sides respectively equal are not necessarily congruent. A full set of formulas of trihornometry is found. The medians are concurrent, but not the altitudes.

Lower reducibility of functions: MARSTON MORSE. Many of the most important problems of modern analysis and mathematical physics are concerned with the existence of unstable equilibria. Stable equilibria are frequently associated with minima, and the classical variational theory is relatively complete for such cases. For unstable equilibria no adequate general existence theory has been developed. A periodic orbit corresponding to the moon has, for example, never been proved to exist rigorously, and it has been shown that if it does exist it affords no minimum to the Jacobi least action integral and is in that sense unstable. The methods of the author when finally developed would appear adequate for solving such problems. The classical condition of lower semi-continuity which with compactness is adequate for proving the existence of minima is not sufficient for establishing the existence of extremals not affording minima. A new condition of *lower reducibility* has been discovered by the author. Roughly stated, it requires the existence of a deformation of the space neighboring a given point p such that the points at which the functional F exceeds $F(p)$ shall be deformed so as to uniformly decrease F. Such a deformation is shown to exist in all ordinary problems, and various important applications have been made.

Electrokinetics XIX. Interfacial energy and molecular structure of organic compounds V. The electric moment of an Al_2O_3: benzene-nitrobenzene interface: ROSS AIKEN GORTNER and HENRY B. BULL. The electric moment of the double layer at the interface between Al_2O_3 and pure benzene, pure nitrobenzene and mixtures of these liquids was studied by streaming potential techniques. A zero electric moment was for the interface in pure benzene, but a very high value was obtained in pure nitrobenzene. In mixtures containing 10 mol per cent. of nitrobenzene the electric moment was inappreciable and a very low value was obtained for mixtures containing 25 mol per cent. nitrobenzene. Only when the nitrobenzene exceeded 50 mol per cent. were high electric moments obtained. The data are tentatively interpreted as indicating the existence in the mixture of a bimolar compound of benzene-nitrobenzene which prevents the polar character of the nitrobenzene from markedly influencing the electric moment. This hypothesis is supported by the fact that benzene-nitrobenzene forms a eutectic mixture at 51 mol per cent. of nitrobenzene.

Mechanism of the reaction of substitution and Walden inversion: P. A. LEVENE and ALEXANDRE ROTHEN. In order to test recently advanced theories of the mechanism of the reaction of substitution claiming that every substitution by a negative atom or group takes place on the positive end of a dipole, experiments were instituted based on the following considerations. If a single reaction of substitution on an optically active carbon atom should lead to inversion of configuration, then two consecutive reactions of substitution should lead to a substance having the configuration of the starting substance. On the basis of the postulate that the substitution of a $-N_3$ group, a pseudo halogen, proceeds similarly to that of a halogen atom, it was possible to show that in the set of reactions

$R—OH \xrightarrow{HI} RI \rightarrow RN_3 \rightarrow RNH_2$ ($R = H—\overset{R_1}{\underset{R_2}{C}}—$, where R_1 and R_2 stand for normal alkyl groups), the configuration of the amine being similar to that of the carbinol, each of the two reactions of substitution is connected with an inversion of configuration. However, when R_1 is an unsaturated radicle, or a phenyl group, C_6H_5, the two consecutive reactions of substitution may lead to a substance having a configuration opposite to that of the starting material, thus showing that only one substitution is accompanied with inversion of configuration, the other proceeding without inversion. Hence, one substitution by a negative ion takes place on the positive, the other on the negative end of the dipole.

The romance of hemoglobin: G. H. WHIPPLE.

On the temperature coefficients of the four transverse magnetic effects in copper: EDWIN H. HALL. The method of experimentation is shown. The investigation, which is not yet ended, indicates that, with a rise of temperature from 25° C. to 85° C., the Hall effect changes less than one per cent., the Ettingshausen effect increases many per cent., the Leduc effect decreases many per cent. and the Nernst effect decreases less, perhaps 7 per cent.

Internuclear distance in oxygen molecules: HAROLD D. BABCOCK. A clearer view of the structure and properties of molecules is the aim of many investigations. The spectroscopic method is particularly useful for molecules consisting of two atoms, among which oxygen affords a favorable case and at the same time has fundamental interest for chemists, physicists and biologists. The theory of molecular spectra has shown that the positions of the spectral lines of a gas may be utilized to determine some of the mechanical properties of the molecule. For example, the distance separating the atoms in the oxygen molecule may be found from measurements of atmospheric oxygen. Recent data give this distance with greatly increased accuracy. Although its value is only about a hundredth of a millionth of a centimeter, variations of the order of a millionth of a millionth of a centimeter are appreciable. The measurements indicate a possible contraction of 2 parts in 10,000 when one of the atoms in the ordinary molecule $O^{16}O^{16}$ is replaced by the rarer heavy oxygen atom of mass 18.

The structure of Langmuir-Blodgett films of stearic acid: L. H. GERMER and K. H. STORKS (introduced by Frank B. Jewett). We have prepared multiple molecular layers of stearic acid upon metal blocks by the method developed by Dr. Katharine Blodgett (*Jour. Amer. Chem. Soc.*, 57: 1007, 1935). Electrons scattered from such built-up surface films produce diffraction patterns consisting of segments of sharp lines lying normal to the specimen surface and arranged along diffuse inclined bands which are parallel and equally spaced. The following conclusions can be drawn from these patterns: (1) The stearic acid is formed into large crystals belonging to the monoclinic system. (2) These are oriented upon the surface with a long crystallographic axis parallel to the long axes of the individual molecules and inclined by 57° to the surface plane, and with two orthogonal axes of lengths 9.4A and 5.0A lying in the surface plane. (3) The crystals possess symmetry characterized by a mirror glide plane normal to the shorter of these axes. This structure is in precise agreement with that of single crystals of stearic acid which we have recently investigated. In these single crystal studies we have discovered different polymorphic modifications. The Langmuir-Blodgett films which we have produced are identical with the modification which we have studied in greatest detail. In our earlier work on these films (*Phys. Rev.*, 50, 676, 1936) we were unable to determine the structure. This work was carried out upon films which had been stripped from the plate upon which they were formed. We now believe that this mechanical treatment produced severe strains and materially changed the molecular arrangement.

The influence of the earth's magnetic field on cosmic ray intensities up to the top of the atmosphere: I. S. BOWEN, R. A. MILLIKAN and H. V. NEHER. Measurement on cosmic-ray intensities such as those made in July, 1936, at San Antonio, Texas, and already published (*Phys. Rev.*, 50: 992–998, 1936), have now been made with equal accuracy in Madras, India. A comparison of the two resulting curves and that earlier obtained in the Fordney-Settle flight makes it possible for the first time to determine experimentally the complete law of absorption of electrons going through the atmosphere in two different ranges of energy, namely, from 2.5×10^3 M E V to 6×10^3 M E V, and from 6×10^3 M E V to 17×10^3 M E V. A law not greatly different from the Bethe-Heitler law as extended by Carlson and Oppenheimer (*Phys. Rev.*, 51: 220, 1937) is found to reproduce reasonably well observed findings.

Cosmic rays and the magnetic moment of the sun: M. S. VALLARTA (introduced by Arthur H. Compton). The indication by Cosyn's stratosphere measurements that the threshold of the latitude effect begins at about 49 degrees for all altitudes may be explained either by (1) assuming that the primary rays have a sharp threshold energy or (2) that particles of smaller energy are prevented from reaching the earth by the action of the magnetic field of the sun. Consequences of the latter hypothesis (suggested originally by Janossy) include diurnal and annual variations in intensity whose agreement with observation is questionable. Any effect due to a possible magnetization of the moon is ruled out because the periodic fluctuations would be greater than is shown by observation.

The structural forces of atomic nuclei: M. A. TUVE, L. R. HAFSTAD and N. P. HEYDENBURG (introduced by W. W. Coblentz). Measurements on the angular scattering of a beam of protons passing through hydrogen gas have resulted in the direct observation and quantitative measurement of attractive forces between two protons when they are brought within nuclear distances of each other, and demonstrate the failure of the Coulomb law of repulsion at very close distances. The measurements show that the proton-proton forces are nearly identical with the proton-neutron and neutron-neutron forces; these three attractive forces are the structural basis for the formation of the nuclei of all the chemical elements. Our observations of proton-scattering in the region 600 to 900 kilovolts gave a quantitative specification of the nuclear forces, as worked out on the basis of the quantum mechanics by Breit, Condon and Present. Observations in the region 200 to 500 kilovolts confirm the results obtained at higher energies and give a very direct demonstration of the fact that the forces between two protons change from repulsion to attraction as they are brought closer together.

Terrestrial effects accompanying several bright chromospheric eruptions: A. G. MCNISH (introduced by F. E. Wright). The recent observation that the intense bright-hydrogen eruptions in the chromosphere on April 8, August 25 and November 6, 1936, were accompanied by simultaneous effects on the earth's magnetism and on radio communication promises a basic advance in the study of the earth's outer atmosphere. Immediately when these bright eruptions were observed with the spectrohelioscope radio signals normally reflected from the *E*-layer and higher layers of the ionosphere ceased to be returned, and a special type of change occurred in the earth's magnetic field. The radio effects indicate that a great increase of ion-density occurred at heights between 60 and 90 km (below the *E*-layer). On the basis of the Stewart-Schuster theory the magnetic effects would be attributable to an increase in electric currents ordinarily flowing in the ionosphere. The beginning of fade-out and magnetic change occurred simultaneously with arrival of visible light from the eruptions. These effects were observed only on the lighted hemisphere of the earth. Thus it is indicated that the ionizing agent was light radiation and not corpuscular radiation. These mutually consistent terrestrial effects may be explained on the assumptions (1) that excitation of gases in the solar atmosphere gave rise to bright-line emission in the ultra-violet region as well as the visible region and (2) that such bright-line emission was much more intense than the ionizing radiation usually coming from the sun. This bright-line emission enhanced ionization, therefore conductivity, below the *E*-layer, where rapid recombination or limitation by absorption prevents high ion-density from normal ultra-violet light. The improved conductivity increased the currents responsible for diurnal variations of the earth's

magnetism and thus caused the unique changes observed. The observed fade-outs of radio signals may be explained by absorption in this region because of high frequency of molecular collisions at these low heights.

Million-volt direct-current x-ray generator for the Huntington Memorial Hospital: J. G. TRUMP and R. J. VAN DE GRAAFF (introduced by Karl T. Compton). This paper describes a 1,000-kv x-ray generator developed by the Massachusetts Institute of Technology and recently installed at the Huntington Memorial Hospital in Boston for the treatment of cancer. The high-voltage source is an electrostatic generator employing six belts, each three feet wide, of commercial belting material and running at about 5,000 feet per minute. The generator operates normally at a steady d-c potential of 1,000-kv with 3 milliamperes on the target, but it can be used over the full range from 400 kv to 1,200 kv. The x-ray tube is continuously evacuated and is of the cascade type, having twenty sections mounted vertically, the potential distribution along the tube being controlled by corona. A lead-shielded steel tube carrying the target at its lower end continues downward from the high-voltage tube well into the treatment room below. This arrangement leaves the treatment room free from all electrical apparatus and high-voltage hazard and permits a wide range of treatment distances. The electron beam is accurately focused on the water-cooled lead target, which is at ground potential, and the radiation transmitted in the downward direction is utilized in treatment. The generator produces an intensity of 100 roentgens a minute at 80 centimeters' distance with 4 millimeters' lead filtration. It is compact, rugged and simple in operation.

Unique crystallization phenomena of protocatechuic acid; motion pictures of automotive crystals: R. W. WOOD. Perhaps the most remarkable phenomenon of crystallization: discovered in 1888 by Otto Lehman and apparently completely lost sight of. The substance crystallizes in four different modifications according to the conditions. The one of especial interest develops branched rods like the claws of a crustacean. The joints straighten out by a progressive motion of the sharp angle of bend (twin-plane), which in one or two seconds runs along the crystal to the tip, the bent rod becoming straight. Thicker rods frequently grow a cluster of spreading claws at the end, which suddenly close together and unite into a single crystal which forms a prolongation of the rod. Large clusters of these crystals form resembling the tentacles of a barnacle, and there is constant movement as the bent rods straighten out and the finger-like tips come together and fuse. Under other conditions long, straight needles form, or rhombs resembling Iceland spar.

The measurement of light signals on moving bodies by transported rods and clocks: HERBERT E. IVES. The equations are developed for describing the times of transit, distances traversed and velocities of light signals on moving bodies, with no restriction on the speeds with which the measuring rods and clocks are moved. The study is based on the assumptions of Fitzgerald, Lorentz and Larmor: (1) That moving rods are contracted in the direction of motion in the ratio

$$\sqrt{1-\frac{v^2}{c^2}} : 1$$

where v is the velocity of the rod, and c the velocity of light; (2) that the frequencies of moving clocks are reduced in the ratio

$$\sqrt{1-\frac{v^2}{c^2}} : 1.$$

The expressions derived are put in terms of the relative velocities of the rods, clocks and bodies concerned, as observed. These expressions are invariant with v, as long as identical measuring procedures are used, *i.e.*, the rods and clocks are moved with the same observed velocities. The velocity of light on a moving body, so measured, is not the constant c, but the product of c and a function of the velocities of transport of the rods and clocks. This function approaches unity as the rod and clock velocities become small. The time of transit of a light signal to a distant mirror on a moving body, so measured, is not half the total to and fro time, but approaches this as rod and clock velocities become small. *The entire set of formulae* approximate the Lorentz transformations as the observed rod and clock velocities become small with respect to the velocity of light.

Differences in mutability in various wild-type lines of Drosophila melanogaster: M. DEMEREC (introduced by A. F. Blakeslee). Mutability of the following wild-type lines was studied by determining the frequency of the occurrence of spontaneous X-chromosome lethals: Florida-inbred; Wooster, Ohio; Formosa, Japan; Oregon-R; Swedish-b; California-C; Huntsville, Texas; Urbana, Ill.; Canton, Ohio; Amherst, Mass.; Woodbury, N. J.; Tuscaloosa, Ala.; Lausanne; Seto, Japan; and Kyoto, Japan. Of these, the first three mentioned had a higher rate of mutability than the other lines. The mutability of the Florida line was 1.09 per cent.; of the Wooster, Ohio, 0.63 per cent.; and of the Formosa line 0.39 per cent., while the average rate for the other 13 lines was only 0.1 per cent. The responsibility for the high mutability rate of the Florida stock was traced to a recessive factor located in the second chromosome. Evidence suggests that this gene is specific in its action: that it increases the mutability rate only in early embryonic development and only in germinal tissues. Such genetic factors influencing the stability of a genom play an important rôle in increasing the variability of the line where present, and thus they may have important bearing on the evolutionary processes within a species.

Bud sports in Datura due to elimination of specific chromosomes: ALBERT F. BLAKESLEE, AMOS G. AVERY and A. DOROTHY BERGNER. In Datura clear-cut cases of bud sports due to mutations in single genes have not been identified. Bud sports due to chromosomal mutations, however, have been relatively common. Those most frequent involve doubling of the whole chromosomal complement to produce a diploid branch on a haploid or a tetraploid branch on a diploid. Elimination of a single chromosome or a chromosome fragment is a not uncommon cause of bud sports. A tabulation of the records for the last 15 years since chromosomal eliminations were first noted shows that such chromosomal deficiencies are con-

fined almost entirely to those which involve the $1 \cdot 2$ or the $17 \cdot 18$ chromosome. The condition is most striking in respect to the $1 \cdot 2$ chromosome. Nearly every season at least a single case is found in which the $1 \cdot 2$ chromosome is eliminated to form a $2n - 1 \cdot 2$ branch. The $\cdot 1$ half of this chromosome seems to be chiefly responsible for the chromosomal elimination. In several cases a $2n + 1 \cdot 18$ plant has produced a 2n branch by the elimination of the $1 \cdot 18$ chromosome, while no $2n + 2 \cdot 17$ plants have shown sectorial deficiencies. The $1 \cdot 1$ chromosome in the secondary $2n + 1 \cdot 1$ type is so frequently eliminated to produce 2n branches that we have found it difficult to keep this type growing without its reverting to normal diploid. The complementary $2n + 2 \cdot 2$ secondary, of which larger numbers have been under observation, has only once been observed to have eliminated its $2 \cdot 2$ chromosome. It is concluded that the rate of chromosomal elimination in the formation of bud sports is different for different chromosomes and that, in the case of the $1 \cdot 2$ chromosome, it is the $\cdot 1$ half which most strongly stimulates the elimination.

A treatment of hosts having opposite effects on leukemic cells of high and low virulence: E. C. MACDOWELL, J. S. POTTER and M. J. TAYLOR (introduced by A. F. Blakeslee). A single treatment of susceptible hosts with embryo tissue of specified genetic constitution will induce resistance to implanted leukemic cells that have become highly virulent in the course of long-continued transfer from mouse to mouse. These hosts are under two months old; if mice of this strain are not treated in any way, nine out of ten will develop leukemic cells spontaneously in later life. However, the identical embryo-treatment, continued at monthly intervals throughout life, completely fails to reduce the incidence of spontaneous leukemia: indeed, the embryo-treatment actually hastens the time of death from leukemia. Failure to induce resistance against spontaneous cancer has led to the general belief that it is not possible to immunize an animal against its own cells. But is this result due to the unique relationship between malignant cells and the animal in which they originate or to the properties of the "spontaneous" cells? This question is answered by breaking the correlation between the animal and its own leukemic cells by means of a single transfer to other hosts. Leukemic cells from a spontaneous case were inoculated into equal numbers of embryo-treated and untreated hosts. Leukemic cells from a long series of transfers (653) were used in the controls. All the controls without embryo-treatment (6) died in 6 days; with embryo-treatment, nine out of ten are alive at 3 months. The "spontaneous" cells in untreated hosts killed in 41 days (average); in embryo-treated hosts, in 32 days. Twenty-one days after inoculation with "spontaneous" cells, 16 of the 20 embryo-treated mice showed large spleens, against 4 out of the 20 mice without embryo-treatment; nine of the embryo-treated mice died before the first of the mice without treatment. Compared with long-transferred cells in untreated hosts, the "spontaneous" cells required nearly seven times as long to kill, although given in doses approximately 80 times as large. The condition in hosts induced by treatment with embryo tissue may at the same time resist the growth of highly virulent, long-transferred cells and facilitate the growth of leukemic cells taken directly from a spontaneous case. The failure of embryo treatment to resist the spontaneous occurrence of leukemia is related to the properties of "spontaneous" cells rather than to the unique relationship between an animal and its own cells.

A developmental analysis of the relation between cell size and fruit size in the Cucurbitaceae: EDMUND W. SINNOTT. The growth of the fruit from ovary primordium to maturity, in this family, is due to an increase in both the number and the size of its constituent cells. Cell multiplication occurs primarily in the early stages, and in tissues other than the epidermis it is finished by anthesis or shortly afterward. During this time cells increase somewhat in size. The bulk of the increase, however (which is often more than 1,000 fold), occurs after the last division and is responsible for most of the increase in fruit size between flowering and maturity. Different tissues behave differently, the inner ones attaining a greater cell size than those toward the periphery. The developmental history also differs between genera and to a less extent between races of the same species.. In *Lagenaria* all pericarp tissues (except the epidermis) stop dividing at about the same cell size, but this is reached first in the inner tissues and later in the outer ones. In *Cucurbita*, however, division stops at about the same time in all, and the relative cell-size differences attained at that time persist to maturity. The point at which cell division ceases, and the extent of cell enlargement, differ markedly in fruits which grow to different sizes. Both cell number and cell size are therefore important factors in determining differences in mature fruit size. Any consideration of the relation between cell size and organ size must evidently take into account these differences between tissues and between genetically diverse races.

Cerebral processes during sleep as studied by human brain potentials: E. NEWTON HARVEY, ALFRED L. LOOMIS and GARRET A. HOBART, III. A long series of records has demonstrated that the electrical potentials of the brain recorded from similar positions on the scalp of normal persons differ greatly in pattern. Two types of individuals with every possible intergrade can be distinguished; at one extreme the type with almost continuous pure alpha (ten a second) rhythm; at the other the type with practically no alpha rhythm but with marked beta (30 to 40 per second) potentials. The potential patterns during sleep are so characteristic that they may be used as a criterion of states or depth of sleep. In a person showing marked alpha rhythm the changes are: (1) More and more marked interruption of the alpha rhythm, (2) complete disappearance of the alpha activity, (3) large random potentials and (4) random potentials plus short bursts of 14 per second rhythm ("spindles"). Disturbance, such as a low sound, during (1) results in the appearance of almost continuous alpha rhythm. Disturbance during (2) and (3) results in bursts of alpha rhythm lasting a few seconds. Disturbance during (4) does not change the record. Return of alpha rhythm is sudden on awakening. The effect was

clearly apparent in one subject who unintentionally fell asleep while trying to carry out a set of instructions, namely, open the eyes during a tone and light signal, and then close them again. The tone and light lasted 5 seconds and was repeated automatically every 30 seconds. The psychological background must be kept in mind in this case, namely, a very sleepy yet conscientious person trying to obey instructions. The record showed that when the eyes were opened the alpha rhythm stopped, and when closed the alpha rhythm continued. This is the normal response of a person awake. The alpha rhythm then disappeared for periods of 20 to 30 seconds and reappeared again even when the light was on. This corresponds to the borderland of sleep when a person can sometimes signal that he is awake and sometimes not. It was quickly followed by a complete change in the record in that the alpha rhythm was replaced by random potentials which were interrupted by a burst of alpha potentials beginning .75 second *after* the tone appeared and lasting 2 to 3 seconds, and another similar burst after the tone stopped. This continued for five minutes and then only random potentials occurred with no alpha rhythm at the beginning or end of tone signal. Another state of sleep had been reached. Soon the 14 a second "spindles" appeared, indicating deep sleep. Shortly afterward a door was slammed, when the continuous alpha rhythm appeared and the subject awoke. During the third state of sleep when the tone signal gave rise to a short burst of alpha rhythm the subject anticipated the tone by 2.5 seconds for three successive half-minute periods. Evidently a subconscious cyclic process of some sort is going on in the brain which is no doubt the basis of our perception of time intervals. Persons with no alpha rhythm show 14 a second "spindles," but otherwise the record looks much the same whether asleep or awake. Our experience with many subjects has trained us to distinguish states of sleep with ease in the type whose alpha rhythm is marked.

Elimination of radium impurities from the blood stream: ROBLEY D. EVANS (introduced by K. T. Compton). In cases of chronic radium poisoning several micrograms of radium element are stored in the bones of the body. The usual metabolic exchange of calcium and other elements between the bones and the blood stream includes the removal to the blood stream of a small fraction of the radium stored in the bones. By increasing some ten thousand fold the sensitivity of the detection apparatus previously used in our studies of the radium eliminated daily in the body wastes, we are able to determine the radium content of 5 cc specimens of blood. Combination of these two experimental results yields information on the efficiency of the eliminative organs in removing heavy element impurities from the blood stream. In human beings the daily elimination, in the case of radium, is the order of ten times the total amount of radium impurity contained in the blood stream at any one time. With appropriate changes in radioactive detection technique, these same principles may be employed in studies of the rate of transfer from the blood stream to the intestine of a number of chemical elements, through the use of their artificially radioactive isotopes as chemical indicators.

Changes in respiratory pattern associated with different types of vocalization: WALTER R. MILES. Human subjects when connected to a closed-circuit respiration spirometer system by means of a helmet fitted with a thin rubber collar which lightly but with air-tight closure encircles the neck can read aloud, talk, sing or engage in other types of vocalization without experiencing any uncomfortable restraint from the apparatus. Graphic tracings of respiration curves recorded under these conditions show characteristic differences according to the type of vocalization. For example, in oral reading the respiration rate is about half as fast as in silent resting (reclining posture in both); the amplitude is approximately twice as deep, the inspiration phase is quicker, and shallow "supplementary" breaths are interspersed at irregular intervals between the deeper inspirations. There is frequently a very conspicuous change in the level of breathing accompanying vocalization. The average expiration level, known to be usually quite stable, falls in singing below that for normal resting. In contrast, oral reading, conversation and, still more strikingly, impromptu speaking, all tend to show a marked increase in the reserve air amounting frequently to as much or more than the value of the tidal air in the same person. After vocalization has ended there is usually a prompt readjustment in the reserve-air volume to the former silent resting level. Psychological factors observed during the study, such as degree of tension and the manner of adjustment, appear to correlate with some of the respiratory changes observed.

Individual differences in communities: EDWARD L. THORNDIKE. Measurements were obtained of 117 cities in over a hundred characteristics, including such as infant death-rate, salaries for teachers, percentage of families paying less than $10 a month rent, percentage of houses with gas, electricity and telephone, and park acreage per person. From the city's scores in twenty-three characteristics where a high score is admittedly an indication of the goodness of life for good people, a score (call it G. G.) for general "goodness" was computed. Cities differ widely in G. G. Their differences in general "goodness" were studied in relation to per capita taxable wealth, to per capita private income and to personal qualities and behavior of the population, such, for example, as are evidenced by owning homes, having children graduate from high school, containing many physicians, nurses and teachers and few male domestic servants. It was found that only 33 per cent. of the variation of cities in G. G. was accounted for by wealth and income, and 60 per cent. by the personal qualities and behavior of its population.

Observations and measurements on the members of the National Academy of Sciences: ALEŠ HRDLIČKA. (Read by title.)

Biographical Memoir of George Davidson: CHARLES B. DAVENPORT. (Read by title.)

Biographical Memoir of Augustus Trowbridge: KARL T. COMPTON. (Read by title.)

Biographical Memoir of George Sumner Huntington: ALEŠ HRDLIČKA. (Read by title.)

Biographical Memoir of Charles Edward St. John: WALTER S. ADAMS. (Read by title.)

Biographical Memoir of Carl H. Eigenmann: LEONHARD STEJNEGER. (Read by title.)

Biographical Memoir of Arthur Gordon Webster: JOSEPH S. AMES. (Read by title.)

OBITUARY

WILLIAM TEMPLE HORNADAY

OVER a span of sixty-six years—or from that day in 1871, when, as a boy of seventeen, he commenced the study of the art of taxidermy at the Iowa State College until he wrote his last article on wild life conservation within a few weeks of his death on March 6—Dr. Hornaday was an ardent and creative force in the field of zoology. The term zoology is used in its broadest sense, since even this brief outline of his life will indicate the many and varied accomplishments which stand as an abiding monument to his creative nature, well-informed mind and impelling sympathy and interest in animal life.

The facilities at the State College soon proved too limited for him, as by this time he was committed to zoology as a life-career, so he summarily left college without graduating and came East to study at Ward's Natural Science Establishment in Rochester, N. Y. Here he rapidly perfected himself in all the branches of taxidermy, and in 1874, when only twenty years of age, he was sent out on his first scientific expedition and within six years his field work had taken him to Florida, Cuba and the West Indies, then to South America, and finally to the Orient—India, Ceylon, the Malay Peninsula and Borneo—from whence in 1880 he returned to the United States with a zoological museum collection said to have been the richest and most varied ever made in the field by one man up to that time.

In that year he formed the National Society for Taxidermists and two years later was called to the position of chief taxidermist of the United States National Museum of Washington. He pursued his work there until 1888, and during this time was requested by the government to conduct an expedition to Montana to obtain specimens of the fast vanishing American bison for mounting and exhibition in the museum. He completed this work with distinct originality, for the method he created in mounting and arranging this group marked the beginning of the now popular museum habitat groups.

During this same period he conceived the idea of the establishment of a National Zoological Park in the nation's capital and brought his plans to reality. Congress appropriated the sum of $292,000 to carry out the project, and Dr. Hornaday was made the superintendent of the new park, which was placed under the control of the Smithsonian Institution. As a consequence of questions of policies which arose with which Dr. Hornaday was not in sympathy, he resigned and at the same time gave up his position in the United States National Museum.

For several years thereafter Dr. Hornaday lived in Buffalo, N. Y., but in 1895, upon the formation of the New York Zoological Society, he was called as director of the Zoological Park—for which plans were then being formulated. No better man could have been selected, for, in the development and carrying out of these plans, which were to place the New York Zoological Park in a premier position among such institutions anywhere in the world, Dr. Hornaday played an energetic and leading part, and it was because of his expert knowledge and creative ability in this position that he soon became known both throughout this country and abroad.

In addition to his primary interest in living animals he realized the permanent advantage which would result from the establishment of a national collection of heads and horns. He consequently formulated plans for this project and obtained enthusiastic endorsement from the officers of the society and a number of sportsmen who were the owners of trophies. Thus were laid the foundations for a national collection which eventually grew to such proportions that a building, the only one of its kind, was erected in the Zoological Park especially to house it, dedicated to the vanishing big game of the world.

His courage and independence of thought were outstanding characteristics, as well as his ability to do more than one thing well at the same time. It was during the early years of his position in New York, even when his duties as director of the park were most onerous, that he—enthusiastically supported by some of the officers of the society, such as the late Professor Henry Fairfield Osborn, Mr. Madison Grant and others—began his active work for the conservation of wild life, which engaged his vital interest up to the very last days of his life. He fought successfully for such measures as the Bayne Law to prohibit the selling of native game; the insertion into the tariff law of the provision against the importation of wild birds' plumage for millinery purposes; the promotion of the international migratory bird treaty between the United States and Canada; the Snow Creek Game pre-

serve in Montana, and the establishment of the Montana and Wichita National Bison Ranges.

Dr. Hornaday's foresight in realizing that wild-life protection work should be placed upon a permanent basis moved him to establish the Permanent Wild Life Protection Fund and with this end in view he raised, by his personal solicitation, an endowment fund, which to-day stands at a figure in excess of $100,000.

His fearlessness and the vigor of his attack frequently made him enemies. The writer of this inadequate appreciation vividly recalls the biting comments of a native Wyoming hunter, who—one night around a campfire—objected with strong expletives to "that man Hornaday in New York, who thinks he can tell us Wyoming people what we ought to do with our game." But Dr. Hornaday's courage and sincerity were potent factors in arousing public opinion. His written words had often the sting of a rapier thrust. He was an unrelenting adversary and it is due to him as much as to any other man in this country that we now have what remains of our heritage of wild life.

All through the years he was a prolific writer, and there is given in a footnote[1] a partial list of the books that flowed from his pen.

To all those who knew him well he was a splendid and loyal friend, and behind the hundreds of admirers who attended his final services, stand the mute inhabitants of our forests and uplands, who found in him a stout-hearted and able defender.

Fairfield Osborn

SCIENTIFIC EVENTS

THE DENVER MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Remarkably low railway excursion rates will be in effect at the time of the Denver meeting of the American Association for the Advancement of Science, from June 21 to 26. For example, a 21-day round-trip ticket from Chicago to Denver will cost only $34.20, with $14.52 additional for a lower Pullman berth. The corresponding fares from Washington, D. C., will be $78.65 and $25.52, respectively. Even from Boston railway fare and Pullman to Denver and return will be only $93.35 and $28.00.

Time schedules have been shortened as much as fares have been reduced. One may now leave Chicago in the early evening on the Burlington Zephyr or the Union Pacific City of Denver and arrive in Denver at about nine o'clock the next morning. The return journey is correspondingly convenient. If the point of departure is New York or Washington, one may leave in the late afternoon or in the evening, arrive in Chicago the next day, and be in Denver the following morning. Therefore, only one day is spent in traveling half way across the continent. And at about the same cost as by railway one may go by plane from Washington or New York to Denver between morning and evening.

By motor the journey requires a much longer time but is cheaper and in certain respects more interesting. The principal highways are excellent, particularly west of the Mississippi River. Service stations, garages, hotels and good tourist camps are found at frequent intervals. Splendidly graded and paved roads lead out of Denver into the heart of the Rocky Mountains. In Rocky Mountain National Park a new paved road ascends by easy grades to the top of the continental divide, along which it extends for several miles. At its maximum altitude it rises to 12,300 feet, and for miles it furnishes a superb view of rugged mountain scenery. Those who do not drive their own cars may also enjoy motoring in the mountains, for buses regularly carry passengers over all the principal scenic routes.

Since the Pacific Division and the Southwestern Division both join in the Denver meeting, the first time the association and its two divisions have met together, eastern scientists will have an exceptional opportunity of meeting and conferring with scientists from the western part of the country, disproving, at least in the case of scientists, the words of Kipling:

> Oh, East is East, and West is West,
> And never the twain shall meet.

F. R. Moulton,
Permanent Secretary

THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

The thirty-first annual meeting of the American Society of Agricultural Engineers will be opened at the University of Illinois for registration on Sunday afternoon, June 30. The program of the college division is scheduled for the first day of the meeting, June 21. General sessions will be limited to two one and a half hour periods on Tuesday and Wednesday, June 22 and 23. The technical sessions will occupy the remainder of those two mornings and Thursday morning, June 24.

[1] Thirty Years War for Wild Life; Two Years in the Jungle; Our Vanishing Wild Life; Wild Life Conservation in Theory and Practice; Taxidermy and Zoological Collecting; Camp Fires on Desert and Lava; Camp Fires in the Canadian Rockies; The Minds and Manners of Wild Animals; A Wild Animal Round-up; Wild Animal Interviews; Old-Fashioned Verses; The Man who Became a Savage.

The afternoons have been left open for individual contacts, inspection trips and special group meetings. The annual dinner is to be held on Wednesday evening and is to be followed by a dance. Other entertainment features planned include an illustrated lecture on Sunday evening, a picnic on Monday evening, an exhibit of plows on Tuesday afternoon and illustrated talks on Tuesday evening. Special entertainment is being planned for women and children during other hours.

Group discussions in the College Division session will be held on education, extension and research. Curricula, subject-matter, service courses, summer camps or courses, administration, graduate work, relations with the Society for the Promotion of Engineering Education and agricultural engineering work will be discussed in the opening program devoted to education. Agricultural engineering extension is to be covered from the angles of relation to other extension work, extension methods, educating employees of agricultural engineers, the vocational program, the 4-H Club program, publications and the U. S. Department of Agriculture Bureau of Agricultural Engineering. Research consideration will be concentrated on project presentation, graduate research and experiment stations. The committee on extension and the student group have scheduled special sessions to run concurrently during a part of the main meeting.

At the opening meeting on Tuesday there will be an address of welcome, the president's annual address and one outside speaker. Another outside speaker and the recipient of the McCormick Medal award will address the general session on Wednesday morning.

The Farm Structures Division will discuss farm housing, the agricultural engineer's responsibility in the promotion of better farm buildings, and papers on individual structural problems and developments. The Power and Machinery Division will give special attention to "The Farm Tractor Fuel Problem," "Quick Attachable and Detachable Power Farming Equipment" and "Natural and Artificial Curing of Forage Crops." The Rural Electric Division will offer sessions on extending electric service in rural areas, assisting the farm customer and electric service for the farm family. In the Soil and Water Conservation Division a wide variety of papers on irrigation, drainage, erosion control and land use problems will be presented.

THE AMERICAN DOCUMENTATION INSTITUTE

THE American Documentation Institute has been incorporated on behalf of leading national scholarly, scientific and informational societies to develop and operate facilities that are expected to promote research and knowledge in various intellectual fields.

A first objective of the new organization will be to develop and apply the new technique of microphotography to library, scholarly, scientific and other material. It will be able to conduct publication by various methods as required by cooperating organizations.

Organized as a Delaware corporation "not for profit" but for educational, literary and scientific purposes, the new organization resulted from a meeting attended by delegates from national councils, societies and other organizations in Washington on March 13. The board of trustees elected consists of: Dr. Robert C. Binkley, Western Reserve University; Dr. Solon J. Buck, director of publications, National Archives; Watson Davis, director, Science Service; Dr. James Thayer Gerould, librarian, Princeton University Library; Dr. Ludvig Hektoen, chairman, National Research Council.

Such a national organization was foreseen as an outcome of Science Service's documentation activities when they were begun in July, 1935, with grants from the Chemical Foundation and conducted with the cooperation of the U. S. Naval Medical School, the Library of the U. S. Department of Agriculture, the Bureau of the Census, the Works Progress Administration, the Library of Congress and other agencies.

The Bibliofilm Service has been conducted by Science Service in cooperation with the Library of the U. S. Department of Agriculture as a service to research workers, and auxiliary publication through microfilm has been conducted by cooperation with leading scholarly and scientific journals. The documentation activities of Science Service now will be transferred to the new American Documentation Institute.

GRANTS IN AID OF RESEARCH OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

AT the April meeting of the American Academy of Arts and Sciences announcement was made of grants in aid of research from the Permanent Science Fund, as follows:

Professor Thomas Harper Goodspeed, University of California, Berkeley, $500 for technical assistance in the cytological, genetic and morphological examination of certain species of Nicotiana as an aid toward the completion of a monograph on that subject.

Professor Rachel Hoffstadt, University of Washington, Seattle, $250 for the purchase of animals and materials needed in a study of the viruses connected with Myxomatosis of rabbits and *Herpes simplex*.

Professor Norton A. Kent, Boston University, $250 to complete the installation of a 30-foot Littrow spectrograph.

Professor Gustav J. Martin, College of St. Teresa, Winona, Minn., $400 for technical assistance and materials needed in an investigation of the chemistry of sili-

cosis to be carried out in collaboration with Dr. L. U. Gardner, of the Saranac Lake Laboratory.

Professors George H. Parker and F. L. Hisaw, Harvard University, $300 for the construction of two open sea live-cars (for keeping dogfish) to be used in their studies of color changes and of reproduction in elasmobranch fishes.

Dr. Roberts Rugh, Hunter College, New York City, $125 for the purchase of materials to be used in a study of the relations and antagonisms of the pituitary and gonad hormones in Amphibia and Mammals.

Curtis W. Sabrosky, Michigan State College, East Lansing, $300 in partial support of a visit to certain European museums as a basis of study preparatory to the writing, not for academic credit, of a monograph on the dipterous family Chloropidae.

Dr. A. W. Sellards, Harvard Medical School, a sum not to exceed $325 for the purpose of having two colored plates (blocks) made to illustrate a paper on the histopathology of murine leprosy.

Dr. T. E. Sterne, Harvard College Observatory, $300 to aid in building highly sensitive thermocouples for measuring thermal radiation of stars.

Inquiries and applications for grants should be addressed to the chairman of the Permanent Science Fund Committee, Professor John W. M. Bunker, Massachusetts Institute of Technology, Cambridge, Mass.

OFFICERS AND MEMBERS ELECTED BY THE NATIONAL ACADEMY OF SCIENCES

AT the annual meeting of the National Academy of Sciences, held in Washington on April 26, 27 and 28, under the presidency of Dr. Frank R. Lillie, of the University of Chicago, Dr. Arthur L. Day, of the Geophysical Laboratory of the Carnegie Institution of Washington, was reelected vice-president for a further term of four years, Dr. H. S. Jennings, Henry Walters professor of zoology at the Johns Hopkins University, was reelected a member of the council, and Dr. Oswald Veblen, professor in the school of mathematics of the Institute for Advanced Study at Princeton, was elected to succeed Dr. Roger Adams, head of the department of chemistry at the University of Illinois.

Dr. August Krogh, professor of zoophysiology in the University of Copenhagen, was elected a foreign associate.

Members of the academy were elected as follows:

Section of Mathematics:
John von Neumann, Institute for Advanced Study, Princeton.

Section of Astronomy:
Seth Barnes Nicholson, Mount Wilson Observatory, Pasadena; Otto Struve, Yerkes Observatory, Williams Bay, Wis.

Section of Physics:
Arthur Jeffery Dempster, University of Chicago.

Section of Engineering:
Oliver Ellsworth Buckley, Bell Telephone Laboratories, New York City.

Section of Chemistry:
Duncan Arthur MacInnes, Rockefeller Institute for Medical Research.

Section of Geology and Paleontology:
Donnel Foster Hewett, U. S. Geological Survey.

Section of Botany:
Charles Thom, U. S. Department of Agriculture.

Section of Zoology and Anatomy:
Francis Bertody Sumner, Scripps Institution of Oceanography, La Jolla; Carl Gottfried Hartman, department of embryology, Carnegie Institution of Washington, Baltimore; Calvin Blackman Bridges, California Institute of Technology.

Section of Pathology and Bacteriology:
Leo Loeb, Washington University, St. Louis; Ernest William Goodpasture, Vanderbilt University; George Richards Minot, Boston City Hospital.

Section of Anthropology and Psychology:
Edward Chace Tolman, University of California, Berkeley.

SCIENTIFIC NOTES AND NEWS

THE Royal Society of Canada has awarded the Flavelle Medal to Dr. Frank Dawson Adams, dean emeritus of the faculty of applied science at McGill University. The award is made in recognition of his researches in geology, particularly those concerned with the ancient metamorphic rocks of Canada and the flow of rocks under pressure.

DR. ARMIN O. LEUSCHNER, director of the Students' Observatory and chairman of the department of astronomy at the University of California, received the honorary membership of the Rittenhouse Astronomical Society of Philadelphia at a special meeting held at the Franklin Institute on April 22. This was "in recognition of his outstanding contributions to the study of asteroids, comets and satellites." Following the ceremony Dr. Leuschner addressed the society on "The Long Range Prediction of the Motion of the Minor Planets."

AT the recent convention in Philadelphia of the Electrochemical Society, the Acheson Medal and Prize

of $1,000 was presented to Dr. Frederick Mark Becket, president of the Union Carbide and Carbon Research Laboratories, Inc., for his contributions to metallurgy. The Weston Fellowship of $1,000 was awarded to Garth L. Putnam, of Seattle, for an investigation of methods of depositing alloys of active metals from aqueous solution. The work will be done at Columbia University under the direction of the secretary of the society, Dr. Colin G. Fink. William A. Johnson, of Pittsburgh, was awarded the prize to young authors for a paper published jointly with Professor Allison Butts, entitled "Studies on Overvoltage."

THE American Chemical Society Prize of $1,000 has been awarded for 1937 to Dr. E. Bright Wilson, Jr., assistant professor of chemistry at Harvard University, for his experimental work in physical chemistry. The award, which is bestowed annually upon a chemist who is under thirty-one years of age and is of unusual promise, will be presented formally to Dr. Wilson at the ninety-fourth meeting of the society to be held in Rochester, N. Y., from September 6 to 10. The prize, which is maintained by Dr. A. C. Langmuir, of Hastings-on-Hudson, N. Y., and his brother, Dr. Irving Langmuir, provides for "recognition of the accomplishment in North America of outstanding research in pure chemistry by a young man or woman, preferably working in a college or university." The chairman of the jury of award was Dean Frank C. Whitmore, of Pennsylvania State College, president-elect of the society.

THE Medal of the Explorers Club, New York City, has been awarded to Rear Admiral Richard E. Byrd, in recognition of his "achievements in Arctic and Antarctic exploration." The presentation was made by Dr. Vilhjalmur Stefansson, president of the club, at a dinner given on April 20. The speakers included Thomas J. Watson, president of the International Business Machines Corporation; David Sarnoff, president of the Radio Corporation of America; Dr. Roy Chapman Andrews, director of the American Museum of Natural History; Captain Robert A. Bartlett, and Lowell Thomas. Sir Hubert Wilkins acted as toastmaster.

DR. THOMAS C. POULTER, director of the Armour Institute of Technology, Chicago, who was second in command of the Byrd Antarctic expedition of 1933–35, was presented on April 27 with a special gold medal by the National Geographic Society. Dr. Gilbert Grosvenor, president, made the presentation in the presence of Rear Admiral Richard E. Byrd. A luncheon followed. On the Byrd expedition Dr. Poulter's work included geophysical investigations, studies of ice conditions, magnetic soundings and observation of meteors and auroral phenomena.

CHARLES M. B. CADWALADER has been elected president of the Academy of Natural Sciences of Philadelphia. He succeeds the late Effingham B. Morris, who served as president from 1928 until his death last January. Since 1928 Mr. Cadwalader has held the office of managing director.

OFFICERS of the Electrochemical Society, which opened its meeting on April 28 in Philadelphia, were elected as follows: *President,* William G. Harvey, Aluminum Company of America; *Vice-presidents,* L. D. Vorce, New York City; R. L. Baldwin, Niagara Falls, N. Y.; O. W. Storey, Chicago, Ill; *Managers,* W. W. Winship, New York City; E. M. Baker, University of Michigan, and Sherlock Swann, Jr., University of Illinois; *Treasurer,* Robert M. Burns, New York City; *Secretary,* Dr. Colin G. Fink, Columbia University.

THE following officers were elected at the annual meeting of the American Society for Experimental Pathology: *President,* C. Phillip Miller, Chicago; *Vice-president,* Morton McCutcheon, Philadelphia; *Secretary* and *Treasurer,* Paul R. Cannon, Chicago; *Incoming Member of the Council,* Shields Warren, Boston. The next meeting of the society will be held in Baltimore in conjunction with the meetings of the Federation of American Societies for Experimental Biology.

DR. FREDERICK H. SAFFORD, of the University of Pennsylvania, has retired after serving for thirty-four years. He has been appointed emeritus professor of mathematics.

DR. RALPH LINTON, of the University of Wisconsin; Dr. George Herzog, of Yale University, and Dr. William Duncan Strong, senior ethnologist of the Bureau of American Ethnology of the Smithsonian Institution at Washington, will become in the autumn members of the department of anthropology of Columbia University. Dr. Franz Boas, who retired as head of the department with the title of professor emeritus on June 30 of last year, joined the faculty as lecturer in 1896 and became professor of anthropology in 1899.

DR. OTTO KRAYER, professor of pharmacology at the American University of Beirut, Syria, formerly of the University of Düsseldorf and the University of Berlin, has been appointed associate professor of pharmacology at the Harvard Medical School for five years beginning next September.

IVAN C. CRAWFORD, dean of the College of Engineering at the University of Idaho since 1923, has been appointed dean of the School of Engineering and Architecture at the University of Kansas. He succeeds Dean George C. Shaad, who died last July.

PROFESSOR JOHN T. STARK has been appointed chair-

man of the department of geology and geography of Northwestern University in place of Professor Charles H. Behre, who has asked to be relieved of the chairmanship to devote more time to research. Professor Stark will return to the university in September after a year spent in a field study of the geology of the Southern Pacific area and attendance at the International Geological Congress in Moscow in July. Professor Behre has been granted a year's leave of absence to attend the congress and to study European zinc deposits.

Dr. W. M. Whyburn, associate professor of mathematics at the University of California at Los Angeles, has been appointed acting chairman of the department of mathematics, to succeed Dr. Earle R. Hedrick, who was recently elected provost of the university.

Dr. Thomas B. Cooley, professor of pediatrics at the Wayne University College of Medicine, Detroit, and chief of staff at the Children's Hospital of Michigan, has been named executive secretary to the council for pediatric research of the American Academy of Pediatrics. The council, which was established in 1935, will include, besides Dr. Cooley, Dr. Kenneth D. Blackfan, *chairman,* and Dr. Fritz B. Talbot, both of Boston; Dr. Alexis F. Hartman, St. Louis; Dr. Irvine McQuarrie, Minneapolis, and Dr. Oscar M. Schloss, New York City.

The *Journal* of the American Medical Association reports that a special board has been appointed to advise the United States Conference of Mayors in the appointment of public health officers. Dr. Joseph W. Mountin, of the U. S. Public Health Service, is chairman of the board. Other members are: Drs. Allen W. Freeman, dean of the Johns Hopkins University School of Hygiene and Public Health; Wilson G. Smillie, professor of public health administration in the Harvard School of Public Health, recently appointed professor of public health and preventive medicine at Cornell University Medical College, New York City; Drs. Huntington Williams, health commissioner of Baltimore, and John L. Rice, health commissioner of New York City.

Professor Dr. F. X. Schaffer, emeritus curator for geology and paleontology of the Natural History Museum of Vienna, is spending the spring and summer in California. He is at Pomona College for the month beginning on April 24, lecturing on topics in structural and historical geology, and will spend the week beginning on May 24 at Stanford University, giving five lectures on topics ranging from alpine structure to the Pleistocene glaciations of central Europe. Later he will become a member of the faculty of the summer session of the University of California at Berkeley.

Dr. Henry V. Howe, director of the School of Geology of the Louisiana State University, and Dr. Richard J. Russell, professor of geography, will sail on May 22 for Russia, where they expect to attend the International Geological Congress to be held in Moscow from July 20 to 29. Dr. Howe will represent the American Association of Petroleum Engineers, and Dr. Russell will be a delegate from the Louisiana State University.

Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology, will lecture under the auspices of the American-Scandinavian Foundation at the Universities of Stockholm, Upsala, Oslo, Lund and Copenhagen during May.

At Northwestern University, Professor Reginald A. Daly, of Harvard University, gave recently a series of six Harris Foundation lectures under the general title, "The Crust of the Earth."

Dr. Robert Broom, paleontologist of the Transvaal Museum, Pretoria, South Africa, gave a lecture on April 22 before a joint meeting of the New York Academy of Sciences and the American Museum of Natural History. His subject was "The Origin and Rise of Prehistoric and Recent Man."

Sir Thomas Holland delivered the Huxley Memorial lecture at the Imperial College of Science and Technology, South Kensington, on May 4. His subject was "The Permanence of Oceanic Depressions and Continental Elevations."

In Science for April 30, the announcement of election to membership in the American Philosophical Society, Class III—Social Sciences, contains an unfortunate error in naming three foreign nominees as having been elected. There was no election of foreign members in this class at this meeting.

The New York State Geological Association will hold its thirteenth annual meeting at Syracuse and vicinity on May 14 and 15. Professor Louis W. Ploger, president, and his associates at Syracuse University are planning two excursions, which will cover the stratigraphic section represented in the classic areas of central New York and which will illustrate the development of the physiographic features of the lake plain and plateau.

The seventh annual Field Conference of Pennsylvania Geologists will be held in Bradford, Pa., on May 28, 29 and 30. The field trips will embrace a study of stratigraphy, structure and paleontology in the Upper Devonian, Mississippian and Lower Pennsylvanian in the Bradford quadrangle and in the Venango oil fields country. A physiographic trip west into the Lake Erie region will be made to study Presque Isle, modern beach phenomena and the elevated shore lines of glacial lakes Warren and Whittle-

sey. A visit will be made to a modern oil refinery and to oil leases where oil is being recovered by the water-flood and by air and gas repressuring. Copies of the final notice may be had by writing to Dr. Arthur B. Cleaves, secretary, Topographic and Geologic Survey, Harrisburg, Pa.

THE Minnesota Academy of Science held its fifth annual meeting at the University of Minnesota on April 17, with some 300 in attendance. At this meeting a new section, Science Education, planned for those whose interests lie primarily in the teaching of the sciences, was added to the two sections, physics and biology, into which the academy had hitherto been divided. In relation to this movement a Junior Academy of Science plan was initiated. The meeting opened with a general session, at which the speakers were Dean Walter C. Coffey and Drs. D. H. Davis, Irving McQuarrie and A. N. Wilcox, all of the University of Minnesota. The three sections held sessions for the reading of technical papers. In a public lecture before the entire group, Dr. H. K. Hayes, chief of the Division of Agronomy and Plant Genetics, University of Minnesota, closed the session with an illustrated talk, entitled "Some Observations on Life in China." The officers for 1938 include: *President,* Dr. W. S. Cooper, University of Minnesota; *Vice-president,* Professor E. T. Tufte, St. Olaf College; *Secretary-Treasurer,* Dr. H. K. Wilson, University of Minnesota; *Councilors,* Professor G. W. Friedrich, St. Cloud Teachers College; Dr. Louis H. Powell, St. Paul Institute; Dean E. M. Freeman, University of Minnesota; Dr. H. E. Essex, the Mayo Foundation. The academy will hold its next annual meeting at St. John's University, Collegeville, on April 23, 1938.

AN International Congress on the Testing of Materials was opened in London at the Institution of Civil Engineers on April 19. According to a report in the London *Times,* the congress, which was organized by the International Association for Testing Materials, was opened by Sir William Bragg, president of the Royal Society. Visitors from twenty-five countries were in attendance. In connection with this meeting a Joint Committee on Materials and Their Testing was set up to act as the British national organization for these matters. Representatives of twenty-two technical institutions and societies will serve on the joint committee, which has been formed on the understanding that it shall not absorb or replace in any way the activities of existing technical organizations. At the conclusion of the congress this committee took over the work of the British committee that had hitherto been entrusted with the activities in Great Britain of the International Association for Testing Materials. The chairman of the joint committee is Dr. H. J. Gough, and the secretary is C. W. J. Taffs, of the Institution of Mechanical Engineers. An exhibition of testing plant and apparatus was held at the Institution of Civil Engineers throughout the week in conjunction with the congress. The Department of Scientific and Industrial Research provided the largest group of exhibits, illustrating testing methods recently devised or developed in the department.

THE Australian Government has announced, according to *Nature,* that the work of the Council for Scientific and Industrial Research is to be extended in the interests of secondary industry generally. Since its establishment in 1926, the council has restricted its attention to problems of the primary producing industries, though no such restriction is imposed upon it by the Act under which it is constituted. It has always been assumed that an extension was only a matter of time in view of the contraction of world markets for primary products and the consequent pressure to increase the home market by expanding secondary industries. A recent decision to establish aircraft and motor production in the Commonwealth has intensified a growing demand for an extension of national scientific research, and an influential committee, including leading engineers and industrialists, is now at work preparing a definite scheme of work. Existing institutions will be utilized wherever possible, but it is fully recognized by the government that considerably increased financial obligations must be carried by it. A first step is to establish an agency for the maintenance of accurate fundamental standards of measurement and for the testing of master gauges for controlling precision manufacture. It is intended that in all developments intimate contact shall be maintained with, and guidance sought from, established British institutions engaged on work of the same type.

DISCUSSION

ON THE SIGNIFICANT FIGURES OF LEAST SQUARES AND CORRELATIONS

DR. F. R. MOULTON in the issue of SCIENCE for December 25, 1936, pointed out that the number of significant figures in the solution of a set of linear equations can not exceed the number of significant figures in the determinant A of the coefficients. By evaluating this determinant it is possible to make certain statements in advance concerning the reliability of the solution for the unknowns. I propose to add some thoughts to those expressed by Dr. Moulton, also to say a word further on the question raised by Dr. Joseph Berkson in SCIENCE for November 13, 1936.

A large class of problems in which these matters assume considerable theoretical and practical impor-

tance is the normal equations of least squares and correlations, though most of what I have to say will apply to any type of linear equations. It is customary to take advantage of the symmetry of normal equations by using Doolittle's method or some modification of it, any of which is but one of many possible algebraically rigorous procedures for "solving" the equations.

The first thing to note is that, given a set of normal equations, a short way of evaluating the determinant A is to proceed with the Doolittle solution or some favored modification of it, exactly as if one were solving for the unknowns. The value of A is then given by the product of certain numbers that naturally occur in the process of elimination; in the illustration to follow, A is the product of the leftmost numbers in the Roman numbered equations. So in dealing with normal equations it is hardly practicable to evaluate the determinant A in advance of solution, but it is helpful to see how its value is tied up with other features of the equations.

The following three normal equations can be used for illustration; a, b and c are the unknowns.

No.	(a)	(b)	(c)	(Const.)
I	$1.994009\,a$	$+\ 1.998994\,b$	$+\ 1.997000\,c$	$=11.982997$
2	$[1.998994\,a]$	$+\ 6.004004\,b$	$+\ 0.002000\,c$	$=14.013002$
3	$[1.997000\,a]$	$+\ [0.002000\,b]$	$+\ 3.000000\,c$	$=11.001000$

The Doolittle solution is laid out as follows, six decimals being retained. In practice the bracketed terms would be omitted for brevity, and a sum column would be introduced for a check. The numbering and procedure follow O. M. Leland's "Practical Least Squares" (McGraw-Hill, 1921) Art. 147. In II; a has been eliminated; in III, a and b both have been eliminated.

No.	(a)	(b)	(c)	(Const.)
4	....	$-\ 2.003991\,b$	$-\ 2.001992\,c$	$=-\ 12.012954$
II	0	$4.000013\,b$	$-\ 1.999992\,c$	$=\ 2.000048$
5	....	....	$-\ 1.999995\,c$	$=-\ 12.000971$
6	....	..	$-\ 0.999989\,c$	$=\ 1.000017$
III	0	0	$0.000016\,c$	$=\ 0.000046$

The solution is practically frozen at the appearance of 0.000016 in column c of III. If but three or even four decimals had been carried, there would have been a complete cancellation at this point. Since 0.000016 contains only two figures, c will be determined to not better than two figures, no matter how many decimals are carried on the right; and the inaccuracy in c will be passed on to a and b in substitution.

The interrelations between the near vanishing of the determinant A, the near vanishing (0.000016) of the coefficient of c in III, the number of decimals carried and the number of significant figures in the values obtained for a, b, c, are now displayed. In the first place, the value of the determinant A is the product of the leftmost numbers in I, II and III, which in this case give

$$A=1.994\times 4.000\times 0.000016=0.00013,$$

indicating that when six decimals are carried throughout the solution, not more than three can be significant in the values found for a, b, c, no matter in what order they are solved for.

The values of c found from III, b from II and a from I in turn are

$$a=1.187844,\qquad b=1.937500,\qquad c=2.875000,$$

wherein, though only two figures are mathematically significant, the presence of all figures written is required for satisfaction of the equations to six decimals. This does not mean that we have somehow evolved accuracy out of inaccuracy; we can in fact round c off to 2.9 even, and find that the set of values

$$a=1.150275,\qquad b=1.950000,\qquad c=2.900000$$

satisfies the normal equations just as well. Seeing this, we may wax bold and try $c=3.15$ without disappointment, for it is a fact that the set

$$a=0.774586,\qquad b=2.075001,\qquad c=3.150000$$

also satisfies the equations to six decimals. Discussion of this apparent vacillation will follow. Dr. Moulton referred to a similar case of instability in a problem in orbits.

The values of a, b and c that satisfy the normal equations absolutely are

$$a=1,\qquad b=2,\qquad c=3,$$

as can be found by solving the normal equations with common fractions (equivalent to carrying all decimals) or by possessing the prescience that these particular ones were built up for illustration from the three equations

$$\begin{aligned} a+\quad\ \ b+c&=6\\ 0.997\ a+1.002\ b+c&=6.001\\ 0\ a+\quad 2\ b-c&=1 \end{aligned}$$

to which they are exactly equivalent. The latter set can be solved by inspection. The small angle between the first two planes, purposefully introduced, is responsible for the instability of a, b, c, and the freezing or near freezing of the normal equations.

So long as A differs from zero by any finite number, however small, there is one and only one value of a, one of b and one of c, that will satisfy the normal equations absolutely. These values can be found by holding to common fractions throughout the solution; and when this is done, any two procedures for solution will give identical and perfect results. There will nevertheless be a band of a values, a band of b values

and a band of c values, not necessarily of the same width, from which can be picked any number of sets a, b, c that will satisfy the equations to the number of decimals required—the greater the accuracy required, the narrower the bands. Moreover, for satisfaction of the equations to a specified number of decimals, the bands can be made wider and wider as A diminishes; in the limit when A is zero the equations are completely indeterminate, which means that a or b or c—one of them (two if A is of rank one)—can be assigned any value whatever for absolute satisfaction of the equations.

The width of each band is in fact the interval within which the corresponding unknown is significantly determined. Different methods of solution are merely devices for picking out from these bands different sets for a, b, c that will satisfy the equations as far as required. If A is small, the bands will be wide, and the results of two different methods of solution may appear alarmingly discrepant, yet be consistent with the equations to the last decimal. In such a situation the equations are said to be unstable, and we have already seen an example. Instability is identified by rather wide bands, and always occurs inseparably from near-indeterminacy and freezing.

The facts just cited have a bearing on interpolation. Suppose a curve with three adjustable parameters a, b, c, be put through three points in the x, y plane. The coordinates of the three points are exactly sufficient to fix a, b and c; and whether a, b and c enter the curve linearly or not, the three equations for determining them can be made linear by Taylor's series. Let now two of the three points be close together but still distinct; then the determinant A of the linear equations is not zero but is small, and the equations are unstable. The points, two of them being close together, and all with (say) four decimal accuracy in the y coordinate and with, for simplicity, absolute accuracy in the x coordinate, do not fasten a, b and c down to definite values, but only require them to lie within rather wide bands—bands of significance, they might be called.

For every value of (*e.g.*) a picked at random from the a band, values of b and c within very narrow limits are required from the b and c bands to satisfy the equations to the number of figures that are significant. Every set a, b, c so satisfying the given equations determines a curve that passes within the vertical distance $\pm$ 0.0001 of each point.

This brings up an angle to the problem easy to overlook: Dr. I. C. Gardner and Mr. L. W. Tilton, of the National Bureau of Standards, mentioned it to me in a recent conversation. For purposes of interpolation we would demand a curve that comes within $\pm$ 0.0001 of each point in order to preserve all the information supplied by the points. In other words, we would demand a set a, b, c that satisfies the equations to the full number of significant decimals, and this will require that the three unknowns a, b, c be mutually consistent to more places than are significant. It is not sufficient to take just any values of a, b and c from within their bands of significance; for interpolation, that is, for satisfaction of the equations as far as significant, we must have a set a, b, c consistent with the points to within 0.0001. For instance, in the solutions written earlier, we may not round off a, b and c to two figures on the pretext that they are significant to only two figures; the fact is that six decimals are required, as written, if the equations are to be satisfied to six decimals. It is permissible, even necessary, to pick one unknown blindly from its band, but the equations themselves must then be permitted to choose the other two. A solution by determinants may well require decimals considerably in excess of the number significant, as Dr. Berkson contended in SCIENCE for November 13: on the other hand, some of this extra labor may be avoided if the earlier unknowns are found by substitution (b from II, a from I, as in the above illustration).

One further item in connection with instability. It is advisable to test for it when it is suspected, but where the freezing was not decisive enough to discourage completion of the problem. By hindsight, it is at times advisable to make the test even when instability is not suspected. A test can be made by comparing the results of two solutions; if they are discrepant, yet both consistent with the equations to the last decimal, there is positive evidence of instability. If two solutions agree tolerably well, the equations may generally be considered stable, though this is only negative evidence.

A very sensitive test for stability is the comparison between the direct solution (substitution, as above) and the reciprocal solution, gotten by using the reciprocal matrix A^{-1} as a multiplier. In least squares and correlation work, the matrix A^{-1} is nearly always calculated anyhow as a matter of course, right along with the solution of the normal equations, since the elements of A^{-1} are the respective variance and product-variance coefficients of a, b, c, and are usually needed. The customary way of calculating A^{-1} is to solve the normal equations with the unit matrix

$$\begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$$

in the constant columns, writing down the values obtained for the unknowns in the same order. Once obtained, the matrix A^{-1} is readily used as a multiplier for finding the values of a, b and c that satisfy any

constant column whatever (*cf.* R. A. Fisher, "Statistical Methods for Research Workers" (Blackie and Son, 1925, 1936) Art. 29). The reciprocal solution, like any other determinant solution, is apt to give spurious results in the case of near indeterminacy, and it is this very fact that furnishes the test of stability.

For the normal equations written above, the reciprocal matrix with two-figure accuracy turns out to be

$$A^{-1} = \begin{vmatrix} 141141 & -46962 & -93922 \\ -46961 & 15625 & 31250 \\ -93922 & 31250 & 62500 \end{vmatrix}$$

The large numbers themselves warn of instability. Used as a multiplier, the top row and the original constant column give

$$a = 141141 \times 11.982997 - 46961 \times 14.013002 - 93922 \times 11.001000 = 2.765577;$$

and in like manner the second and third rows give

$$b = 0.852883, \qquad c = 1.705766.$$

The glaring discrepancies between these values and the earlier solutions are evidence of instability, but of course no test was needed in this instance. If common fractions had been used, or all decimals retained, the reciprocal solution would have given $a = 1$, $b = 2$, $c = 3$, which satisfy the equations absolutely.

Some of the notions here expressed have grown from a few ideas brought to my notice by Dr. A. C. Aitken, of the University of Edinburgh, about two years ago; in particular, the suggestion of the reciprocal solution for comparison is his. Such notions concerning near indeterminacy and instability occur readily enough to mathematicians, but not so readily to other scientists and economists who have use for them. The reader will understand that only the algebraic features of the problem are here dealt with; physical significance of figures is another matter. It is interesting, I think, to see that there are both mathematical and physical aspects to the problem.

W. EDWARDS DEMING
BUREAU OF CHEMISTRY AND SOILS
U. S. DEPARTMENT OF AGRICULTURE

PERANEMA AND "GRANTIA"

CONCERNING the second flagellum of *Peranema*,[1] I can only repeat that after prolonged study of normal active specimens under oil immersion I was not able to see any such structure. However, Lackey[2] and Hall[3] have already pointed out that this second flagellum can not be seen in the living animal and is not used in locomotion. My observations were confined to live specimens, and the flagellum is evidently observable only in stained specimens. I was obviously in error in doubting its existence on the grounds of its non-visibility in life. Since writing the article in question[4] I have been able to observe the vacuolar apparatus in *Peranema* and other euglenoid flagellates, and I find that the recent accounts of this apparatus in *Peranema* are erroneous, as is likewise the standard text-book description of the vacuolar system of the Euglenida in general. The contractile vacuole of *Peranema* is a temporary vesicle which discharges into the gullet base and thus completely vanishes, having *no continuity with the succeeding vacuole.* As each vacuole reaches diastole there appear near it two or three small vacuoles. These are not, as usually supposed, secondary vacuoles opening into the main vacuole, but are simply the droplets whose fusion forms the next vacuole. As the current vacuole disappears, these droplets tumble together into the space *which it occupied and unite to become the next vacuole.* A similar state of affairs was found to hold for several other euglenoids, both green and colorless, studied.

Dr. de Laubenfels' correction, in the same number of SCIENCE, of an obvious error in the naming of the common little syconoid sponge of the Woods Hole vicinity is welcome, but unfortunately Dr. de Laubenfels *omits to mention that Scypha is a synonym of Sycon.* Sponges with the structure of the Woods Hole form have always up to the present been placed in the genus *Sycon* by sponge specialists, and the erroneous name *Grantia* was already corrected to *Sycon* (on the advice of Professor H. V. Wilson and myself) in the last editions of Pratt's "Manual of the Common Invertebrate Animals" and Drew's "Invertebrate Zoology." It now appears that the name *Scypha* has priority over *Sycon*, and hence it will unfortunately be necessary to change the name *Sycon* to *Scypha*. The form *Scypha* (*Spongia*) *coronata* given by de Laubenfels does not conform to the international rules of nomenclature, for a parenthesis can be used in this manner only to indicate a subgenus, as is certainly not the intention here. Consequently the name of the Woods Hole sponge (assuming that the specific identification is correct) should read *Scypha coronata* (Ellis and Solander) 1786, syn. *Spongia coronata* Ellis and Solander.

LIBBIE H. HYMAN
LABORATORY OF EXPERIMENTAL BIOLOGY,
AMERICAN MUSEUM OF NATURAL HISTORY

[1] SCIENCE, February 19, 1937.
[2] *Biol. Bull.*, Vol. 65.
[3] *Trans. Amer. Micro. Soc.*, Vol. 53.
[4] *Quart. Jour. Micro. Sci.*, Vol. 79.

A REMARKABLE SABRETOOTH-LIKE CREODONT FROM THE EOCENE OF UTAH

DIRECTOR AVINOFF, of the Carnegie Museum, has kindly sent me for description the lower jaw of a predaceous animal, the nature of which is not apparent

at first glance. Examination, however, proves that it is one of the primitive suborders of the Carnivora, the Creodonta, and the remarkable feature is the way in which it has imitated the sabretooth cats of the true Carnivora. The dental formula of the lower jaw is $I_{\overline{3}}\ C_{\overline{1}}\ P_{\overline{4}}\ M_{\overline{2}}$. The second molar is a cat-like sectoral. The lower jaw has protective flanges from the anterior part, which demonstrate that the upper canines were large sabres. The position of the condyle of the mandible and the shape of the coronoid process show that this animal was far advanced in specialization equal to that of the White River *Eusmilus*, the most specialized of all the sabretooth cats. For this fossil the name *Apatælurus kayi* is proposed, the specific name in honor of Mr. J. Leroy Kay, of the Carnegie Museum, who made the discovery.

W. B. SCOTT

PRINCETON UNIVERSITY

SOCIETIES AND MEETINGS

THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

THE Wisconsin Academy of Sciences, Arts and Letters held its sixty-seventh annual meeting at the Milwaukee Public Museum, Milwaukee, Wisconsin, on April 9 and 10, conjointly with the Wisconsin Archeological Society and the Midwest Museums Conference. About 125 persons attended the meeting.

After a short general session the papers to be read were divided into two sections: Section A, devoted to papers dealing with archeological and museum subjects; and Section B, devoted to papers concerning the several sciences. Fifty-six papers were presented, and these were divided equally between the two sections. Mr. Charles E. Brown, director of the Wisconsin Historical Museum, served as chairman of Section A, and Dr. Chancey Juday, president of the academy, presided over Section B.

The academy held its annual business meeting at 4:30 o'clock on Friday afternoon, at which time it elected twenty-three new members, accepted the resignations of Mr. Walter M. Smith, librarian, and Dr. R. R. Shrock, secretary-treasurer, and elected Mr. Gilbert H. Doane, librarian, and Dr. Loyal Durand, Jr., secretary-treasurer.

The annual academy dinner was held at the Hotel Schroeder at 6:00 o'clock on Friday evening, with 44 in attendance. Immediately after the dinner, members and guests returned to the museum, where Drs. Joel Stebbins and A. E. Whitford, of the Washburn Observatory, presented the evening lecture on "Gadgets and Galaxies," in which they demonstrated the use of the photo-electric cell in the study of stars and galaxies. The audience numbered over 150.

Officers for 1937–38 and 1938–39 are as follows:

President, Chancey Juday, University of Wisconsin.
Vice-president in the Sciences, Paul W. Boutwell, Beloit College.
Vice-president in the Arts, S. C. Wadmond, Delavan, Wisconsin.
Vice-president in Letters, Julia Grace Wales, University of Wisconsin.
Secretary-Treasurer, Loyal Durand, Jr., University of Wisconsin.
Librarian, Gilbert H. Doane, University of Wisconsin.

R. R. SHROCK,
Secretary-Treasurer

THE ARKANSAS ACADEMY OF SCIENCE

THE twenty-first annual meeting of the Arkansas Academy of Science was held at the University of Arkansas, at Fayetteville, on March 26 and 27.

The annual public lecture was presented by Dr. T. S. Painter, of the University of Texas, and the title of the address was "Recent Developments in Our Knowledge of Chromosome Structure and Their Bearing on Genetics." The lecture was presented under the combined auspices of the academy and the University of Arkansas Sigma Xi Club.

A feature of the meeting was a Conservation Symposium. The following speakers contributed to the meeting as follows: "The Conservation of the Minerals of Arkansas," G. C. Branner, state geologist; "Soil Conservation," G. E. Riddell, assistant state coordinator, Soil Conservation Service; "Wild Fowl Conservation," Robert Smith, White River Migratory Waterfowl Refuge, U. S. Biological Survey; "Relation Between Forest and Game Preservation," H. A. Miller, White River Migratory Waterfowl Refuge, U. S. Biological Survey; "Forestry in a Conservation Program," R. D. Stevens, University of Arkansas; "Conservation Aspects of the Resettlement Administration," T. Roy Reid, regional director, Resettlement Administration, Region 6.

The following officers were elected for 1937–38: *President,* W. C. Munn, Magnolia A. and M. College; *Vice-president,* T. L. Smith, College of the Ozarks; *Secretary,* L. M. Turner, University of Arkansas (re-elected); *Treasurer,* W. R. Horsfall, University of Arkansas (re-elected); *Editor,* I. A. Wills, John Brown University.

The 1938 meeting will be held at the College of the Ozarks, at Clarksville.

LEWIS M. TURNER,
Secretary

A SYMPOSIUM ON THE CALCULUS OF VARIATIONS

A SYMPOSIUM on the calculus of variations was held at the University of Notre Dame on April 7 and 8. The first of the four meetings under the direction of Dr. Marston Morse, of the Institute for Advanced Study, Princeton, was opened by some remarks of Dr. Karl Menger, of the University of Notre Dame, who described as the purpose of the symposium the establishment of further relations between the different directions in calculus of variations; metric methods which yield general existence theorems, as well as a new proof of Euler's equation, may be one of the means. Dr. Gilbert A. Bliss, of the University of Chicago, presented a paper on "Normality and Abnormality in the Calculus of Variations." Dr. Lawrence M. Graves, of the University of Chicago, spoke on "The Reduction of Certain Problems in the Calculus of Variations to the Problem of Bolza."

At the second meeting, which was directed by Dr. G. A. Bliss, Dr. Tibor Radó, of the Ohio State University, presented a paper on "The Method of Variation of the Independent Variable." He demonstrated how this method could be successfully applied to the solution of the problem of Plateau. In the discussion, Dr. S. Lefschetz and other speakers emphasized the importance of the application of the modern methods to two-dimensional problems. Dr. William T. Reid, of the University of Chicago, used expansion methods to obtain sufficient conditions for the one-dimensional problems in the calculus of variations. The last speaker of the second meeting was Dr. Sumner B. Myers, of the University of Michigan, who treated certain aspects of differential geometry in the large.

The following morning, on which Dr. Solomon Lefschetz, of Princeton University, presided, Dr. Marston Morse spoke on "Abstract Variational Theory." He explained his new general theory of stable curves, divided into a group-theoretical and a metrical part. Dr. Edward J. McShane, of the University of Virginia, presented his general proofs of existence theorems.

In the afternoon, under the direction of Dr. Lincoln LaPaz, of the Ohio State University, Dr. Karl Menger discussed the applications of his metric methods to the proof of very general existence theorems. The rest of the meeting was devoted to applications of the calculus of variations. Dr. Charles F. Roos, of New York City, dealt with applications to economics, in particular with problems to the building industry; he derived formulas which had yielded predictions for the last three years. Dr. Lothar W. Nordheim, of Purdue University, spoke on "Variational Problems in Quantum Electrodynamics." Dr. Arthur E. Haas, of the University of Notre Dame, presented a paper on "The Variation Principles of Maupertuis and Fresnel, and the Relation between Wave Mechanics and the Theory of Relativity."

On the first evening Dr. Lefschetz gave a popular lecture on the subject "What is Topology?"

The meeting was attended by a group of more than fifty visitors from all parts of the country.

KARL MENGER

SPECIAL ARTICLES

RESTORATION OF CARBOHYDRATE OXIDATION IN DIABETIC TISSUE IN VITRO[1]

SINCE Houssay's notable demonstration that pancreatic diabetes in the experimental animal is ameliorated by the removal of the hypophysis, it is no longer possible to regard diabetes mellitus as conditioned solely by a lack of insulin or to consider that normal carbohydrate metabolism is governed by this hormone alone. It is now generally held that the proper utilization of carbohydrate is under the control of two or more internal secretions in a delicate balance, insulin on the one hand, and on the other, a secretion or secretions elaborated in the pituitary or in other glands, as the adrenals (Long, Lukens) under hypophyseal control.

Experiments on the whole animal of various species have shown that the removal of the hypophysis following pancreatectomy results in a diminution or absence of glycosuria and ketosis, especially under fasting conditions, during which low blood sugar values are also found. Carbohydrate metabolism in these animals is not, however, entirely normal. Chambers, Sweet and Chandler[2] have shown that while the basal respiratory quotient is definitely higher in the Houssay dog than in pure pancreatic diabetes, they show an inconstant rise in the level of the respiratory quotient on receiving glucose.

Tissues removed from the same group of Houssay animals and studied in this laboratory in the Barcroft-Warburg micro-respiration apparatus have shown a more marked return to the normal than might have been anticipated from the results obtained with the whole animal. For example, strips of skeletal muscle

[1] From the Department of Medicine, Cornell University Medical College and The New York Hospital, New York City.

[2] Chambers, Sweet and Chandler, *Proc. Am. Physiol. Soc.*, Memphis, April, 1937.

were found to retain the ability to resynthesize added lactate in entirely normal fashion, in contrast to similar tissue from depancreatized dogs, which lose this function.[3] In addition, basal respiratory quotients as well as those obtained in the presence of lactate were definitely higher than in the diabetic animal. More recently, a comparison of slices of cardiac muscle of normal, depancreatized[4] and Houssay dogs (unpublished data) revealed an even more striking return to a normal carbohydrate metabolism in the last group, to judge by basal respiratory quotients equal to those of normal animals, and a rise to the neighborhood of unity on the addition of glucose and lactate.

From the superiority of the carbohydrate metabolism of these excised tissues of the Houssay dog, as compared with the behavior of the whole animal, it might be inferred that there still exists in the whole animal inhibitory factors, from which the tissues on removal from the body are released. The potentialities for carbohydrate metabolism can then be more fully realized. They would seem, from these findings, to be independent of insulin, provided the other factors—arising from the pituitary or from organs controlled by the pituitary—are absent as well. Even in excised cardiac tissue from depancreatized dogs, something of the same nature can be shown. For, although these tissue slices have lost the ability to respond to the addition of glucose or lactate by an elevation of respiratory quotient, their basal quotients may be quite high—up to 0.89—indicating an ability to oxidize preformed carbohydrate; whereas, in the heart-lung preparation, according to the carefully controlled experiments of Cruickshank and Startup,[5] the respiratory quotient of the diabetic heart is always around that of pure fat oxidation—0.70.

The main purpose of this note is to report in brief experiments carried out in this laboratory with Eugene Cohen and Muriel Malam, which may have a bearing on the rôle of insulin and these hypothecated inhibitory substances in carbohydrate metabolism. Cardiac tissue was removed from completely depancreatized dogs for study in the Warburg apparatus. The dogs received no insulin at any time, and were fasted for three days prior to the experiments, which were carried out seven days after pancreatectomy. The tissues were prepared with sterile precautions, and one batch run at the start to determine its initial respiratory metabolism in a non-nutrient Ringer-phosphate solution and in the presence of 0.2 per cent. glucose. The rest of the tissue was incubated at 37.5° C. in sterile Ringer-phosphate pH 7.4 containing 0.2 per cent. glucose. Similar respiratory measurements were made at the end of five and ten hours. The results have been assembled in Table I.

TABLE I

THE RESPIRATORY QUOTIENT OF EXCISED CARDIAC TISSUE OF DIABETIC DOGS FOLLOWING PROLONGED INCUBATION IN RINGER-GLUCOSE-PHOSPHATE AT 37.5° C.

Dog no.	Medium	Respiratory quotient: Initial	after 5 hrs.	after 10 hrs.	O_2 cons. cc/gm/hr.: 0	5	10
1	non-nutrient	0.77	0.84	0.90	0.72	0.54	0.51
	glucose 0.2 per cent.	0.74	0.89	0.94	0.62	0.46	0.49
2	non-nutrient	0.74	0.81	0.81	0.71	0.87	0.72
	glucose 0.2 per cent.	0.73	0.82	0.88	0.82	0.89	0.68
3	non-nutrient	0.72	0.77	0.85	0.84	0.43	0.37
	glucose 0.2 per cent.	0.72	0.92	1.11	0.74	0.55	0.39
4	non-nutrient	0.78	0.82	0.78	0.64	0.95	1.00
	glucose 0.2 per cent.	0.78	0.86	1.00	0.65	1.06	0.65
5	non-nutrient	0.76	0.85	0.90	0.44	0.38	0.34
	glucose 0.2 per cent.	0.71	0.94	1.05	0.47	0.43	0.43
Average diabetic	non-nutrient	0.75	0.82	0.85	0.67	0.63	0.59
	glucose 0.2 per cent.	0.73	0.89	0.99	0.66	0.68	0.53
Normal	non-nutrient	0.81	0.89	0.89	0.47	0.68	0.57
	glucose 0.2 per cent.	0.89	0.92	1.00	0.54	0.74	0.86

It is apparent that a definite change in the metabolism of the tissues occurred with prolonged incubation under these conditions. The capacity to oxidize carbohydrate, judging from the higher basal quotients and the definite response to glucose, has become quite like that of normal cardiac tissue. In the tissue from the normal animal a similar increase in the degree of carbohydrate metabolism can also be seen. Attention should be called to the fact that, with prolonged exposures, the level of oxidation in two out of five experiments fell appreciably; although the effects on the respiratory quotient do not appear to be dependent on this fact, to judge from the experiments in which the fall was trivial. Preliminary experiments with other tissues, such as voluntary muscle and kidney, indicate that this phenomenon is not confined to the heart.

[3] Shorr, Richardson and Sweet, *Am. Jour. Physiol.*, 116: 142: 1936.

[4] Shorr, Malam and Richardson, *Proc. Am. Physiol. Soc.*, Memphis, April, 1937.

[5] Cruickshank and Startup, *Jour. Physiol.*, 81: 153, 1934.

On the basis of these experiments, one is tempted to draw certain inferences. It is very unlikely that there is any significant amount of insulin left in the tissues seven days after pancreatectomy, in view of the careful work of Best, Jephcott and Scott.[6] It may be postulated that there is present, initially, some factor or factors, inhibitory of carbohydrate oxidation, not by direct neutralization of insulin, but by a depression of some phase in the chain of carbohydrate oxidation. Unchecked by insulin in the diabetic organism, the effect is profound. During the incubation at body temperature *in vitro,* this inhibiting factor is somehow destroyed or lost to the cell. Whereupon the tissue can resume its full primitive potentiality for carbohydrate oxidation, without the need for participation of insulin in the process. In the normal tissue also, there is a factor limiting the extent of carbohydrate metabolism, whose influence wears off on incubation. Whether or not the increased carbohydrate oxidation in this case is due to unchecked insulin action or is independent of it can not be judged from this experiment. Basically, oxidation of carbohydrate can be divorced from the action of insulin, whose main function in the organism may be to act in an opposite direction to the inhibitory factors. This conception would fit in very well with the phenomena of the Houssay dog, or the adrenalectomized-pancreatectomized animal, as well as with the findings on the tissues of the Houssay dog reported above. It would help clarify the situation in human diabetes, where a pancreas, histologically intact and containing insulin, may be present. It would help explain the tenacity with which some tissues, particularly muscle, hold on to their carbohydrate stores in conditions such as fasting, instead of prodigally using up this easily oxidized substance.

But such tempting inferences must be tentative until there is much more in the way of experimental data. The phenomena reported could be due to a pathological state in the tissues, attendant on prolonged exposure to these relatively unphysiological conditions, or to changes in cell permeability. That the tissue may be damaged to some extent by the long period of incubation is apparent from the occasional depression of respiration which takes place.

It is the aim of experiments now going on in this laboratory to evaluate these several possible explanations of an interesting phenomenon.

EPHRAIM SHORR

DEPARTMENT OF MEDICINE, CORNELL UNIVERSITY MEDICAL COLLEGE, AND THE NEW YORK HOSPITAL

[6] Best, Jephcott and Scott, *Am. Jour. Physiol.*, 100: 285, 1932.

TRICHOMES OF INCIDENTAL IMPORTANCE AS CENTERS FOR LOCAL VIRUS INFECTIONS

STUDIES have been made to evaluate the importance of trichomes and other epidermal cells as points of entry for virus that causes local infections when the inoculum is wiped over the leaves of suitable species. Although the trichomes do serve as centers for local virus infection, their importance in comparison with other cells of the epidermis seems to have been overestimated.

Inoculations were made through the trichomes by cutting them from the leaf surface or mutilating them with a fine instrument while immersed in a small drop of fresh virus extract under a dissecting microscope, magnification 28 ×. Cutting 2,290 trichomes from leaves of *Nicotiana sylvestris* Spegaz. and Comes resulted in 2.2 per cent. positive local infections. Inoculations by mutilation of all the trichomes on small areas of leaves of *N. sylvestris, N. glutinosa* L. and *N. rustica* L. resulted in 35, 22 and 12 per cent. of the expected local infections, respectively. The expected number of infections was determined by wiping the inoculum over the opposite halves of the leaves on which the above tests were made.

Since trichomes are very sparse on the leaves of pepper, *Capsicum frutescens* L., it was possible to avoid them and inoculate small areas of the epidermis. These inoculations were made under a dissecting microscope by using an elbow bent in a fine flexible wire or a padded pin head to lightly rub the inoculum over the epidermis. Care was taken to avoid bruising or breaking trichomes or making wounds which might be apparent at this magnification. The ordinary cells of the epidermis were very susceptible to inoculation by a very light rubbing, since approximately the expected number of local infections was obtained.

The right halves of 47 *Nicotiana sylvestris* leaves were wiped with virus-free water and allowed to stand from two to six days before inoculation of the entire leaf by wiping. The first wiping of the right halves of the leaves destroyed about 95 per cent. of the trichomes and there was very little evidence that other cells of the epidermis had been injured. After inoculation it was found that the number of necrotic lesions was reduced 6.8 per cent. on the right halves of the leaves which were wiped twice in comparison with the left halves of the leaves which were wiped only at the time of inoculation. This experiment was repeated with 43 leaves, except that fine carborundum dust and water were used for the first wiping of the right halves of the leaves. This wiping destroyed about 98 per cent. of the trichomes, and many of the ordinary cells of the epidermis were severely injured or killed. After

inoculation it was found that the number of necrotic lesions was reduced 31 per cent. on the right halves which were wiped twice in comparison with the left halves which were wiped only at the time of inoculation.

If trichomes were of major importance as points of entrance for inoculum, their destruction would be expected to cause a greater reduction than 6.8 per cent. in the number of local infections when leaves were inoculated later. The importance of the ordinary cells as points of entrance for inoculum is evident, since severe injury to some of them reduced the number of local infections 25.2 per cent. as compared to the 6.8 per cent. reduction when practically all the trichomes were severely injured or destroyed and little injury was observed in the ordinary cells.

Pepper and *Nicotiana sylvestris* leaves have approximately 16 and 346 trichomes per square centimeter, respectively. When pepper leaves were inoculated by wiping in the usual manner, 82.4 per cent. of the local infections showed no relation to trichomes. In contrast on leaves of *N. sylvestris* 39.87 per cent. of the lesions showed no relation to trichomes, 20.26 per cent. of the lesions had a broken trichome in the periphery of the lesion and 39.87 per cent. had a broken trichome in the center of the lesion.

It was pointed out earlier in this note that 35 per cent. of the expected number of lesions resulted on leaves of *Nicotiana sylvestris* when all the trichomes on small areas were inoculated without injury to other epidermal cells. This 35 per cent. is consistent with the 39.87 per cent. of the total lesions observed to have trichomes in their centers on the wiped leaves, and for this reason these lesions on the wiped leaves are considered to be the result of inoculation through broken trichomes. The 20.26 per cent. of the lesions having a broken trichome in their periphery are considered to be the result of an inoculation through an epidermal cell near to the trichome.

It is evident that many ordinary epidermal cells serve as infection centers and that the larger percentage of infections through trichomes of *N. sylvestris* is due to the greater number of trichomes on a given leaf area as compared to pepper.

L. W. BOYLE
H. H. MCKINNEY

BUREAU OF PLANT INDUSTRY
U. S. DEPARTMENT OF AGRICULTURE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE DEVICE FOR MEASURING THE ABSORPTION RATES OF SOILS

A FUNDAMENTAL factor in determining the extent of run-off and erosion from western watersheds in times of torrential rain or rapid melting of snow is the rate at which the soil will absorb surface water and conduct it into underground channels, where it ceases to be an erosive agent but percolates to the vast soil and rock reservoirs which feed the springs. Recognizing the important rôle played by this soil function in watershed management, the Intermountain Forest and Range Experiment Station has developed an apparatus to measure the rate of absorption with a minimum of disturbance to the soil. The unit is inexpensive to construct, simple to operate, and its small size and light weight permit the study of soils in their undisturbed state on areas accessible only by foot.

The apparatus includes a water reservoir (Fig. 1 *a*), made by grinding the bottom from a quart bottle, and a distributor (*b*), built of ¼-inch brass pipe and fittings, which delivers water in a thin sheet to the upper side of a one-square-foot plot enclosed by suitable baffle plates (*c*). As the water flows over the plot some is absorbed at a rate determined by the nature of the soil, the steepness of the slope and the kind of vegetation present; and the excess passes into the run-off trough (*d*) and a manually operated tipping bucket (*e*), where its rate of flow is measured. The difference between the rate of application and the rate of run-off is the rate at which water has been absorbed by the soil.

The rate of application is controlled by a globe valve and is determined by observing the time required for successive measured portions of 300 cc each, contained in cans (*f*), to pass through the distributor. At the start of a run, the reservoir is filled to the level of the pointer (*g*) and one measured portion is added. When, after the application is started, the water level again drops to the tip of the pointer, the delivery of one measured portion is indicated and the elapsed time is recorded. Another measured portion is then added and the run continued. The variation in head caused by the intermittent addition of portions of water has no significant effect upon the rate of flow through the system.

At the termination of each time interval during which a measured portion of run-off has been applied to the plot, the tipping bucket is tipped so that the run-off from the next 300 cc application is caught in a separate container. Subsequent measurements of these run-off portions indicate the rate of run-off, and by subtraction from the rate of application, the rate of absorption is determined.

After the first one or two minutes of the run, the absorption rate of the plot becomes nearly constant, and can be compared directly with corresponding rates on other plots. Replicate determinations on the

same or adjoining plots are easily made, and consistently accurate results are obtained. The unit has proved its worth in two recent studies by this station. In a comparative study of plots supporting a single range plant and adjacent barren plots, use of the unit

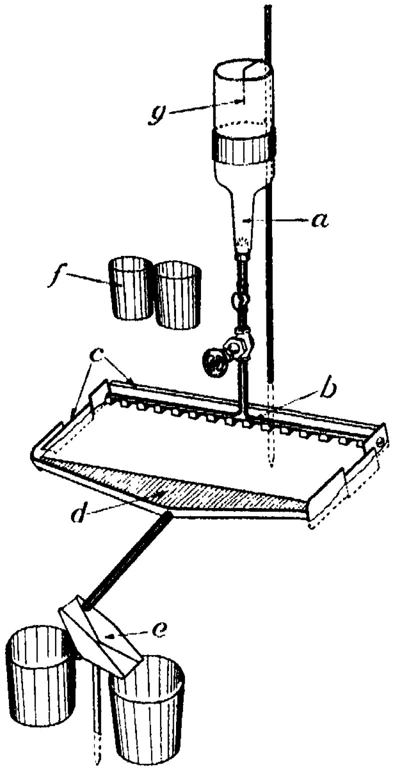

FIG. 1

has indicated that fibrous-rooted plants, such as grasses and mesophytic forbs, are approximately 2½ times more effective in promoting absorption of surface water than are tap-rooted species typical of depleted range.[1] Another study indicated that the rate of absorption by the granitic soils of the Boise River watershed was influenced much more by organic matter content than by either moisture content or textural variations. Such studies emphasize the importance of an adequate plant-cover in range-watershed management, both directly in promoting absorption and indirectly in building up the soil organic matter.

A limited supply of complete specifications for the construction and operation of the above apparatus, for use by persons interested in this technique, are available upon request to the Director, Intermountain Forest and Range Experiment Station.

C. KENNETH PEARSE

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
OGDEN, UTAH

[1] C. Kenneth Pearse and Samuel B. Woolley, *Jour. Forestry*, 34: 884–887, 1936.

BOXES FOR STUDY SKINS

DOUBTLESS many laboratory instructors in mammalogy and ornithology have felt the need for a protective cover for the study skins, which received rough treatment by careless and awkward students. This need is greater when the skins that must be used are record skins. Such was our problem when we discovered that two new products, Plastocele and Pyralin, can be cut or sawed and cemented.

Providing a skilful student with this material, acetone and study skins he made 26 boxes for mammals ranging in size from mice to marmots at an average cost per box of 35 cents for material and 25 cents for labor. The cement made by dissolving small waste pieces and the sawdust in acetone sealed the sections firmly together, making airtight containers that are light, transparent and durable. Additional boxes made for mammal and bird skins and the entire set used during our winter quarter show only the inevitable finger marks and light scratches, and the latter do not obstruct the view of the snug-fitting, fully protected skin within.

Plastocele and Pyralin are practically identical for these boxes, the former costing slightly more. We learned about these two products of the du Pont Viscoloid Company at Arlington, N. J., from Dr. Shillinger, of the United States Department of Agriculture, who suggested their use for museum jars.

J. S. STANFORD

UTAH STATE AGRICULTURAL COLLEGE

BOOKS RECEIVED

CANDLER, A. C. *Atomic Spectra and the Vector Model.* Vol. I: *Series Spectra.* Pp. vi + 237. Illustrated. Vol. II: *Complex Spectra.* Pp. 279. Illustrated. Cambridge University Press, Macmillan. $8.50, set of two vols.

HEATH, DAISY W. *Comprehensive Index of the Publications of the American Association of Petroleum Geologists, 1917–36.* Pp. 382. The Association, Tulsa, Okla.

MCCLUNG, C. E., Editor. *Handbook of Microscopical Technique; For Workers in Animal and Plant Tissues.* Second edition, revised. Pp. xvii + 698. 82 figures. Hoeber. $8.00.

OSGOOD, WILLIAM F. *Functions of a Complex Variable.* Pp. viii + 257. $3.00. *Functions of Real Variables.* Pp. xii + 399. $4.00. University Press of National University of Peking, China.

RAMSEY, A. S. *Electricity and Magnetism; An Introduction to the Mathematical Theory.* Pp. x + 267. Cambridge University Press, Macmillan. $3.25.

Travaux de l'Association Internationale de Géodésie. Tome 13, Fascicule 1. *Rapports Nationaux sur les Travaux Exécutés dans les Différents Pays. Établis à l'Occasion de la Sixième Assemblée Générale, Edimbourg, 14–25, Septembre, 1936.* Secrétariat de l'Association, Paris.

WARNER, W. LLOYD. *A Black Civilization; A Social Study of an Australian Tribe.* Pp. xviii + 594. 9 plates, 3 figures. Harper. $5.00.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

PRELIMINARY ANNOUNCEMENT OF THE DENVER MEETING

Edited by Dr. F. R. MOULTON
PERMANENT SECRETARY

THIRTY-SIX years ago, in 1901, the fiftieth meeting of the association was held in Denver, Colorado. This year the one-hundredth meeting of the association will also be held in Denver, from June 21 to 26. The approaching meeting will be particularly important because for the first time the Pacific Division and the Southwestern Division will join in a meeting of the entire association. Many of the affiliated societies, both of the association and of its two divisions, are combining forces to make the one-hundredth meeting a memorable occasion.

At the fiftieth meeting of the association Dr. Charles Sedgwick Minot, of Harvard University, distinguished for his work in medical sciences, was president of the association. For the one-hundredth meeting another Harvard University scientist is president, Dr. George D. Birkhoff, an internationally famous mathematician.

The local arrangements for the meeting are in charge of an executive committee, of which Dr. James J. Waring is chairman and Dr. J. C. Stearns is secretary. There is also a general committee for the meeting, composed of a large number of distinguished citizens of Denver and the surrounding region.

THE DENVER REGION

(Material furnished by the Local Committee)

Denver, a city of about 300,000 population, is situated on the plains just east of the Rocky Mountains. This great barrier, and the altitude, one mile above

sea level, provide an unusual and most invigorating climate for the city.

Denver is, first and foremost, a residential city. It has no tenement district, no manufacturing or industrial population of any importance. Primarily, the business of the city is one of distribution: Denver is the clearing house for and trade center of a vast and rich district, the main products of which are cattle, metals, coal and foodstuffs.

Universities and colleges in the Denver area boast of student bodies entirely above the relative population of the district. Responsible for this are Colorado's matchless, year-around climate and unusual scenic attractions. The assurance of a delightful background and most pleasant environment for work and play, as well as the general excellence of these institutions of higher learning, lure students from all parts of the continent.

So close to the heart of the city are Denver's mountain parks that it is a matter of only minutes from the classroom to the magnificent playgrounds with their scenic delights and cool streams from higher altitudes. Paved roads radiate from down-town Denver into the mountain country that always is beckoning. It is never more than 45 miles from Denver's city hall to a glacier and perpetual snow.

Students of botany delight in the floral growth of the district, extending from plant life on the plains to the nearby watered lowlands and on up through a cavalcade of spring and summer ornamentation on the lofty mountain sides. Devotees of mineralogy are offered a rare natural laboratory for study. The same is true for those interested in wild animal and bird life. Although Colorado has the highest average altitude of any state in the union, it presents noteworthy variety—mysterious desert wastes with shifting sands that once were the bed of inland seas, grassy plains, the largest irrigated areas on the continent and the incomparable Colorado Rockies with their vast succession of peaks of more than 14,000 feet.

Denver is the center of a compact district offering ten major educational institutions. Largest of the educational institutions in Colorado's capital is the University of Denver. Its picturesque setting on the hilltop campus faces the mountain range. Students are offered courses in liberal arts, commerce, science and engineering, and fine arts and music. These, with the graduate school, the school of law, the summer school, school of librarianship, department of social work and the university college, make up a distinguished cultural organization.

Although the University of Colorado is located in near-by Boulder, it operates in Denver a widely known school of medicine and hospital admirably located and staffed. This school of medicine was opened in 1883. In 1911 it was united with the Gross College of Medicine, the two faculties being combined into one. Since that time the growing single unit has been a division of the University of Colorado. On the campus at Boulder the state university, beautifully situated at the entrance to the mountains, offers many advantages for the student from other states. Its summer sessions are staffed with prominent educators from all parts of the country.

In Denver also is located Regis College, a long-established and distinctive college for men and boys.

An accredited college for women, of which Denver and Colorado are justly proud, is the Colorado Woman's College, located at Denver. About 12 miles from the heart of Denver is the Colorado State School of Mines, the largest institution of the kind in the world. Situated in the mountain foothills, at Golden, near where the first gold was discovered in Colorado, the 75-year old school boasts of students from most of the major countries of the world.

The Colorado State College of Agriculture and Mechanic Arts is at Fort Collins, 65 miles north of Denver. The Colorado State College of Education is at Greeley, only fifty miles from the capital. Colorado College, a large coeducational institution, offering the usual university subjects, is an endowed school, located at Colorado Springs at the foot of Pike's Peak, 75 miles to the south of Denver.

Preparatory schools, military academies, art institutions and schools operated in the mountain ranch country form a most intriguing chain of institutions designed for the upbuilding of mind and body of boys and girls; junior colleges and smaller "normals," scattered advantageously about the state, have their important place in Colorado's interesting educational life.

Headquarters and Registration

General hotel headquarters for the association and for all groups meeting in Denver will be the Cosmopolitan Hotel, where the registration office for the meeting will also be located. This hotel is in the center of the business district, conveniently located to all places at which sessions will be held. The office of the permanent secretary will also be located in this hotel. Mail, telegrams, etc., may if desired be addressed to Registration Headquarters, A. A. A. S., Cosmopolitan Hotel, Denver.

Registration will be open upon payment of a fee of \$1.00 to all persons who are interested in the advancement of science and education. Each registrant will receive a copy of the program, an identification card and a badge. Registration will be necessary for attendance upon the general reception and participation in other events planned by the local committee. The registration office will be open for the convenience of

those arriving early on Sunday afternoon, June 20, from 2:00 to 5:00 o'clock.

Hotels in Denver

Many of the hotels are cooperating with the association for the meeting. Members desiring accommodations are expected to communicate directly with the hotels. The following rates for rooms with bath will apply:

Cosmopolitan: (general headquarters): Single, \$3–\$5; double, \$5–\$8.
Adams: Single, \$2.50–\$3; double, \$3.50–\$4.
Albany: Double \$4–\$8.
Argonaut: Single, \$2.50–\$4; double, \$4–\$7.
Auditorium: Single, \$2–\$3; double, \$3–\$4.50.
Barth: Single, \$2–\$2.50; double, \$3.50–\$4.
Brown-Palace: Single, \$3.50–\$4; double, \$6–\$8.
Colorado: Double, \$3–\$4.
Cory: Single, \$2.50–\$4; double, \$3.50–\$6.
Crest: Double, \$3.50–\$6.
Dover: Single, \$2–\$2.50; double, \$3–\$3.50.
Oxford: Single, \$2.50–\$3; double, \$3–\$5.
Roosevelt: Single, \$3–\$4; double, \$4–\$7.
Sears: Double, \$5–\$6.
Shirley-Savoy: Double, \$4–\$6.
Standish: Single, \$2–\$3.50; double, \$3–\$6.

Excepting the Cosmopolitan, Brown-Palace, Cory and Sears, all hotels have rooms without bath at considerably lower rates. The Argonaut will furnish suites to accommodate three or more persons at \$7.50 and up; the Auditorium will furnish two-room suites, with one bath, for four persons at \$6 to \$8.

Transportation

Summer excursion railway fares will be in effect for the Denver meeting from all points in the United States. A few sample round-trip rates are as follows:

From	Season ticket	21-day ticket	Round-trip Pullman fare (extra)
Boston	\$100.15	\$93.35	\$28.00
Chicago	41.00	34.20	14.52
Detroit	56.70	49.90	18.00
New York	93.35	86.55	26.52
Philadelphia	88.15	81.35	25.52
Washington, D. C.	85.45	78.65	25.52

It is advisable for all who plan to attend the meeting to consult their local ticket agent for accurate information regarding the possibility of reduced fares for shorter periods than those above listed.

Press Service

(From Austin H. Clark, Director)

Representatives of all sections of the press are cooperating with the association for the purpose of making known throughout the entire country, and also abroad, the proceedings of the Denver meeting.

We who are occupied with science in this country receive our support directly or indirectly from the American public. Year by year the public is becoming increasingly interested in what we are doing. Their knowledge of what we are doing comes to them through the medium of the press. So it is incumbent upon the members of the association to provide the press with all the material it may wish to use.

All who will present papers or addresses at Denver are requested to make sure that the Press Service is supplied with copies of their manuscripts as long in advance as possible. Two copies of each paper, each accompanied by an abstract, should be sent to the Press Service at Washington.

Manuscripts are made available for study by the representatives of the press as soon as received. The earlier they are received the more time there is to study them and to prepare full and accurate accounts of their contents. Early receipt of manuscripts is of great benefit and advantage to all concerned—especially the authors.

The Press Service is for your benefit, as well as for the benefit of the association and of science as a whole. Its success depends upon your cooperation.

General Sessions

On Tuesday evening Dr. Herbert M. Evans, professor of biology and director of the Institute of Experimental Biology of the University of California, will deliver his address as retiring president of the Pacific Division of the Association. The title of Dr. Evans's address is, "The Development of our Knowledge of Anterior Pituitary Function."

On Wednesday evening the Maiben Lecture will be delivered by Professor Nevil V. Sidgwick, F.R.S., of Lincoln College, Oxford, England. "Molecules" is the subject chosen by Professor Sidgwick for his address.

On Thursday evening, Dr. A. E. Douglass, professor of astronomy and director of the Steward Observatory of the University of Arizona, will deliver the John Wesley Powell lecture of the Southwestern Division. The subject of Dr. Douglass's address is "Tree-Rings and Chronology." These lectures and their addresses were described more at length in Science for April 30, 1937.

"The Scientific Aspects of the Control of Drifting Soils" is the topic chosen for the General Symposium on Thursday afternoon at 2 o'clock. This symposium is sponsored jointly by the Ecological Society of America and the Association. The geological aspect which deals with the origin and distribution of the soils in the Great Plains Region will be presented by Dr. M. M. Leighton, chief of the Illinois Geological Survey. The biological factors are to be treated by Dr. Frederic E. Clements, plant ecologist of the Carnegie Institu-

tion of Washington. The effects of man in disturbing established conditions and the organization of means of control form the subject of the third paper by Dr. H. H. Bennett, director of the Soil Conservation Service.

SOCIAL EVENTS

On Monday evening the local committee will give an informal reception to visiting scientists in honor of the officers and the members of the American Association. This reception will be held at the Reed Library of the University of Denver. A dinner for all biologists is scheduled for Wednesday evening. The Society for Research on Meteorites will have its dinner at six o'clock on Tuesday evening, and the American Society of Plant Physiologists will hold its dinner on Thursday evening. The local committee has planned for Friday afternoon a trip into the mountains, to be followed by a buffet supper. This excursion promises to be very attractive to all who are able to accept the invitation of the local committee. All visiting scientists are invited.

EXCURSIONS, FIELD TRIPS AND DEMONSTRATIONS

Since the region about Denver offers exceptional attractions for field studies in natural history, sections and societies are planning to take advantage of the opportunities afforded. Many field trips have already been organized in geology, biology and anthropology and by other groups, some of which are optional and some of which are necessarily limited to special groups or to a limited number of participants. Some information will be found in the announcements of programs, but precise data will be obtainable on registration in Denver. A number of exhibits and demonstrations are being planned by various societies and incorporated in their programs.

Saturday has been set aside for excursions to educational and other institutions in the region of Denver. These excursions will offer a splendid opportunity to those attending the meeting to become acquainted not only with the institutions but with the individuals and the work they are doing in their respective fields of science. Arrangements are being made for trips to Boulder, Colorado Springs, Fort Collins, Golden and other important points. Unfortunately one can not participate in all these excursions in one day. A desk in the registration office will be provided where reservations may be made.

OFFICIAL NOTICES

The executive committee of the association will meet on Sunday afternoon and evening, June 20, and the council will hold its first session on Monday at 2:00 P.M. Later sessions will be held at 9:00 o'clock on other days as decided. By rule, all business is presented to the council through the executive committee. Members are requested to forward items for the council to the permanent secretary's office in Washington until June 15. After that date items should be sent to the permanent secretary addressed to the Cosmopolitan Hotel, Denver, Colorado.

The executive committee of the Pacific Division will hold luncheon meetings daily from Monday to Friday at 12:15 P.M. The meeting of the affiliation committee of the Pacific Division will be held on Tuesday afternoon at 4:30. A general business session of the division will be held on Tuesday evening immediately after the general session of the association.

Full data regarding participants, time and place of various events and other details will be found in the official program of the meeting, which will be distributed to members on registration in Denver.

SECTION MEETINGS AND SOCIETY PROGRAMS

The Section on Mathematics (A) will hold a joint session with the Section on Social and Economic Sciences (K) and the Econometric Society on Thursday morning. Among those who will participate on the program are Professor J. A. Shohat, Dr. Gerhard Tintner and Professor G. C. Evans.

The Section on Physics (B) will hold a joint session with the American Physical Society, Pacific Coast Branch, for a symposium on "Cosmic Physics" on Saturday morning, with papers by Dr. Thomas H. Johnson, of the Bartol Research Foundation, and Professor Hurd C. Willett, of the Massachusetts Institute of Technology. A third paper for this symposium will be arranged.

The American Physical Society will meet on Friday and Saturday, holding sessions in conjunction with the Section on Physics (B) and the Astronomical Society of the Pacific and the Section on Astronomy (D). The session with the two latter organizations will probably consist of a symposium on "Solar Radiation and Radio Reception," and will be held on Friday morning. On Saturday morning the Physical Society will join with the symposium program of the Section on Physics (B). The Saturday afternoon session will be devoted to the presentation of short contributed papers.

The American Meteorological Society plans full-day sessions on Monday, Tuesday and Wednesday and, if necessary, forenoon sessions on Thursday and Friday. Papers dealing with air-mass analysis as applied to the western United States, the geometrical theory of halos, the auroral afterglow, atmospheric pressure at heights above 40 miles and the atmospheric factor in the "Dust Bowl" problem are some of those which will be up for discussion. On Thursday afternoon the members will join with the Ecologists for the an-

nounced program of that group. There will be opportunity for visits to points of meteorological interest.

The American Association of Physics Teachers will meet on Thursday morning and afternoon. The morning session will be occupied with papers contributed by members and the afternoon session by a special program of several invited papers.

The Hydrology Section of the American Geophysical Union will hold a joint session with the Society of American Foresters on Tuesday morning. Other sessions have been arranged for programs on the subjects of consumptive use and return flow, rainfall and runoff, physics of soil moisture, dynamics of streams and underground waters.

The Section on Chemistry (C) will hold three half-day sessions, in cooperation with local sections of the American Chemical Society. A number of interesting papers by individuals carrying on fundamental research have been arranged.

The Section on Astronomy (D) will hold joint sessions with the Astronomical Society of the Pacific and the Southwestern Division. A joint session with the Section on Physics (B) and the Astronomical Society of the Pacific is being arranged, to be held on Friday morning for a discussion of subjects of common interest.

The Astronomical Society of the Pacific and the Section on Astronomy (D) will hold two or more sessions for the presentation of papers on astronomical subjects, and on Friday morning will hold a joint session with the American Physical Society, the Section on Physics (B) and the Section on Astronomy, at which three invited papers will be presented on the general topic "Radio Transmission and Solar Phenomena."

The fifth annual meeting of the Society for Research on Meteorites will be held on Tuesday and Wednesday. "Meteoric Craters" will be the subject for a joint session with the Section on Geology and Geography (E) on Tuesday afternoon. At six o'clock on Wednesday evening, June 23, there will be a dinner for members and their guests at the Denver Athletic Club. The sessions will be held at the Colorado Museum of Natural History, where a large collection of meteorites will be on display for those interested.

The Section on Geology and Geography (E) will open its program on Tuesday afternoon, when it will meet jointly with the Society for Research on Meteorites. The remainder of the week will be devoted to papers and field trips, in all of which the varied aspects of Rocky Mountain geology will be featured. Wednesday morning has been set aside primarily for stratigraphic and structural papers, and Thursday morning will be utilized for the same purpose if further discussion of Rocky Mountain problems seems more vital than a half-day field trip. An examination of foothills structures near Lyons, under the guidance of Dr. W. O. Thompson, and other members of the Department of Geology, University of Colorado, is scheduled for Wednesday afternoon; and local trips, featuring Mesozoic stratigraphy, structure and economic geology, will be arranged for Thursday morning if an indoor meeting does not prove more urgent. The general symposium on "The Scientific Aspects of the Control of Drifting Soils" is scheduled for Thursday afternoon, and in view of the wide-spread interest in this subject, the Section on Geology and Geography will not hold any competing meetings. On Friday morning a symposium on Rocky Mountain geomorphology has been arranged, at which papers covering varied phases of this field, and ranging geographically from New Mexico to Montana, will be presented. On Saturday morning, Dr. F. M. Van Tuyl will lead a geomorphic field excursion into the mountains, and the trip will end at Science Lodge, where the members of the section will be the luncheon guests of the University of Colorado's Geology Department. Among the speakers scheduled to present papers at the several sessions are Wallace W. Atwood, Margaret F. Boos, W. O. Thompson, F. M. Van Tuyl and P. G. Worcester, in addition to representatives from the Harvard, Iowa, Princeton, Smith, Wyoming and other university groups which are also carrying on field research in the Cordilleran region.

The Oceanographic Society of the Pacific will hold sessions for contributed papers on Wednesday afternoon and Thursday morning. The annual luncheon of the society will be held on Thursday at noon. A symposium has been arranged for Thursday afternoon on "Inter-relations of the Sciences Which Compose Oceanography," with papers by Professor H. U. Sverdrup, of the Scripps Institution of Oceanography at La Jolla, California; Professor A. H. Hutchinson, of the University of British Columbia, and Professor B. S. Henry, of the University of Washington.

The Section on the Zoological Sciences (F) will meet on Tuesday, Wednesday and Thursday. The sessions on Tuesday have been assigned to Parasitology, with a general session in the morning and a symposium in the afternoon. The program for Tuesday is being arranged by Professor John W. Scott, of the University of Wyoming. On Wednesday and Thursday mornings papers of general zoological interest are to be presented. Wednesday afternoon has been tentatively set aside for demonstrations. On Thursday afternoon the section joins with the General A. A. A. S. Symposium, arranged by the Ecological Society, on the subject of "The Scientific Aspects of Drifting Soils." Members of the section are invited to a complimentary luncheon at Science Lodge, near Boulder,

on Saturday. Correspondence regarding the program and titles submitted for the general session should be addressed to the secretary of the section, Professor George A. Baitsell, Yale University.

The American Association of Economic Entomologists will meet on Thursday and Friday. The sessions will open with a brief business meeting, followed by presentation of papers. There will be sessions for papers on Friday afternoon and on Saturday morning and afternoon. The Entomologists' dinner will be held at 6 o'clock on Thursday.

The American Society of Parasitologists will be represented by a program on Tuesday. The morning session will be devoted to the reading of papers, including invited papers on *Diphyllobothrium latum* and closely related species found in North America. The speakers will include Dr. William L. Jellison, Dr. T. B. Magath, Dr. Justus F. Mueller and Dr. John W. Scott. At the afternoon session a symposium on "Rocky Mountain Spotted Fever" will include papers by Dr. R. R. Parker, director of the Rocky Mountain Spotted Fever Laboratory, Dr. Cornelius B. Philip, Dr. Herald R. Cox and one other speaker on "Sylvatic Plague."

The American Society of Ichthyologists and Herpetologists (Western Division) will devote its sessions on Tuesday morning and afternoon to fisheries problems and papers on the habits, taxonomy and distribution of reptiles, amphibians and fishes.

The Section on Botanical Sciences (G) will meet in joint session with the Western Section of the American Society of Plant Physiologists, the Pacific Section of the American Phytopathological Society, the Pacific Section of the Botanical Society of America and the Western Society of Naturalists on Wednesday afternoon, June 23. The program will include a group of invitation papers. Dr. Frederic E. Clements, of the Carnegie Institution of Washington, will give an illustrated address on environment and expression in species. Dr. A. R. Davis, of the University of California, will discuss his investigation of the interrelationships of environmental variables in plant growth. Dr. J. T. Barrett, of the University of California, will give a report on his studies of the lower forms of parasitic Phycomycetes. Dr. L. L. Burlingame, of Stanford University, will speak on the anomalous inheritance of white anther in *Clarkia elegans*. Dr. R. B. Harvey, of the University of Minnesota, will give a talk on winter resistance in plants.

The American Phytopathological Society will hold sessions for the presentation of papers on Wednesday morning and Thursday under the auspices of the Pacific Division. Wednesday afternoon will be devoted to a joint meeting of the Section on Botanical Sciences, at which Dr. J. T. Barrett, of the University of California, representing the Phytopathological Society, will present a paper on "Observations on New or Little-known Phycomycete Root Parasites." On Friday and Saturday plant pathologists of the Pacific Division have been invited to participate in a meeting of the Upper Mississippi Valley group to be held in Estes Park. This meeting will consist of group discussions, presentation of invitation papers and optional scenic trips.

The American Society of Plant Physiologists, in joint session with the Western Section of the society, will begin its meetings on Tuesday morning, with a symposium on "Chlorosis" conducted by Dr. W. W. Aldrich. The Western Society of Soil Science has tentatively arranged to join in this meeting. Tuesday afternoon will be devoted to short papers. On Wednesday morning, Dr. F. W. Went will conduct a symposium on "Plant Hormones." This will be followed with a luncheon to which all those particularly interested in the details of hormone research will meet and discuss the problem further. In the afternoon, the society will join with the other affiliated societies for a meeting of the Section on Botanical Sciences. One of the speakers is Dr. Frederic E. Clements, who will speak on "Environment and Expression in Species." This meeting will be followed by the Biologists' dinner. On Thursday morning, Dr. A. H. Hendrickson will conduct a symposium on "Drought Resistance in Plants." Thursday afternoon and Friday morning will be devoted to short papers. On Thursday evening the plant physiologists will have a dinner, to be followed with an address by the president of the society, Dr. R. B. Harvey. Friday afternoon and evening will be spent in sight-seeing and picnicking.

The American Fern Society will not hold an indoor meeting for the reading of papers, but will take a field trip to study some of the notable ferns of the Boulder Canyon on Sunday, June 20, and/or Monday, June 21.

The Ecological Society of America will hold two sessions, one of which will be a symposium on "Conservation Management of Wildlife," on Wednesday morning, presided over by Dr. H. L. Shantz, director of the U. S. Division of Wildlife Management, with three other speakers from the states of Colorado, Wyoming and Utah. On Thursday morning, a session will be held for presentation of papers. The general symposium, under the joint auspices of the society and the American Association, will be held on Thursday afternoon, on "The Scientific Aspects of the Control of Drifting Soils," including various features of conservation in the Great Plains. The society has arranged a Biologists' Dinner, without speeches, for Wednesday evening, preceding the evening lecture of the association. Field trips will be a special feature of the program. These will be under the guidance of

botanists, zoologists, geologists and others, who will explain matters of interest in biology, geology, conservation projects and scenic features. On Tuesday, an all-day excursion will be made through the Denver mountain parks to Echo Lake and the summit of Mt. Evans. The foothills of the Rockies, the montane zone, timberline and the alpine region will be visited. On Wednesday afternoon, a four-hour excursion will be made to the Garden of the Red Rocks and Lookout Mountain. The Great Plains and the foothills will be considered. For the week-end of Saturday-Sunday, June 26–27, a choice of two excursions may be made. If desired, portions only of these may be taken. One trip will be to the Colorado Springs and Pike's Peak region, with visits to the U. S. Soil Conservation projects near the Springs, and to the Alpine Laboratory of the Carnegie Institution of Washington, on the slopes of Pike's Peak, with its transplant gardens. Scenic features will include the Garden of the Gods, South Cheyenne Canyon and Seven Falls, and Pike's Peak. The other week-end excursion will be to the Rocky Mountain National Park, to observe various types of vegetation and animal life in different altitudinal zones of the Rockies, and spending Saturday night at Science Lodge of the University of Colorado at 9,500 feet elevation.

The Western Society of Naturalists will meet jointly with the Section on Botanical Sciences, with one speaker to represent the society on the program. There will be another session for presentation of papers. Members of the society will join with other biologists in the Biologists' Dinner to be held on Wednesday evening.

The Section on Anthropology (H) will meet on Wednesday and Thursday. The Department of Indian Art of the Denver Art Museum will be host to the section. The program will be built around the relationships, or lack of them, between the Plains, Southwest, Texas and Southern California areas, with discussions concerning relative chronologies and influences. It is planned to spend Friday visiting the Lindenmeier Folsom Site and the archeological collections at the University of Colorado. If there is sufficient interest, a trip will be made on Saturday to Colorado Springs to visit the new Taylor Museum for Southwestern studies, Colorado College and other institutions in that city. Time will be allowed for visiting the Indian exhibits of the Art Museum, the State Historical Society, the Colorado Museum of Natural History and the Department of Anthropology of the University of Denver.

The Section on Psychology (I) will hold sessions on Monday and Tuesday. There will be papers from leading psychologists throughout the West, including the Rocky Mountain region, the Southwest and the Pacific Coast. Included in these sessions will be a dinner meeting at the Cosmopolitan Hotel. Other features will be symposia on topics of vital interest in psychology, excursions to Rocky Mountain parks, a visit to the High Altitude Laboratory on Mt. Evans, and visits to psychology laboratories in adjacent institutions, such as the University of Colorado at Boulder, Colorado State College at Ft. Collins, Colorado College at Colorado Springs, and the Colorado State College of Education at Greeley.

The Section on Social and Economic Sciences (K) will feature joint meetings of affiliated and related societies, including the Econometric Society, the American Statistical Association, the Sociological Research Association and Pi Gamma Mu, honorary social science society. On Thursday evening the participating societies will unite in a general meeting, to be addressed by Dr. Carl Snyder, for many years with the Federal Reserve Bank in New York, who will speak on "New Foundations for an Economic Science." Dr. Stuart A. Rice, of the Central Statistical Board, will preside. A luncheon meeting on Friday will be addressed by Dr. George Gallup, conductor of nationwide surveys of popular reaction to public questions, on "Measuring Public Opinion." His paper will be discussed by Dr. Claude Robinson and Dr. Louis Bean. The meeting will be open to all psychologists, sociologists, statisticians and other interested scientists.

Three sessions are scheduled by the Econometric Society: the first in joint session with the Section on Mathematics (A) on "Mathematical Economics," on Thursday morning, under the chairmanship of Dr. C. F. Roos, of the Mercer Allied Corporation, with Professors G. C. Evans, of the University of California, H. T. Davis, of Indiana University, and Gerhard Tintner, of the Cowles Foundation, as speakers; the second on Thursday afternoon in association with the Section on Mathematics and the American Statistical Association, the topic to be "Mathematical Probability and Statistics," with Dr. E. R. Hedrick, of the University of California at Los Angeles, acting as chairman, and speakers including Professors J. Shohat, the University of Pennsylvania, Holbrook Working, Stanford University, and E. L. Dodd, the University of Texas; the third scheduled Saturday morning on "Inflation," to include James Harvey Rogers, of Yale University, and Lionel Edie, of the Capitol Research Company.

In addition to joining with the Econometric Society on Friday morning, the American Statistical Association has arranged a session for Thursday morning on the subject of "The Organization and Technique of National Statistical Surveys" and a session for Friday morning on the subject of "Family Expenditures, Public Health and Social Security."

The Section on Engineering (M) plans to hold a group of independent and joint sessions, under the leadership of a special committee of the Colorado Engineering Council and with the cooperation of the Foresters Association. The Engineering Section meeting is planned for Monday afternoon, June 21, followed by foresters' meetings on Tuesday and Wednesday, all day, June 22 and 23. On Thursday, June 24, there will be inspection trips, one for the engineers and one for the foresters. A program of mutual interest to both engineers and foresters is being arranged with the desire that both engineers and foresters attend in common the meetings arranged by each. The Section on Engineering is fortunate in securing the cooperation of the Colorado Engineering Council, which comprises within its membership the local membership of the national professional engineering societies. Arrangements for the meetings are in charge of a committee of the Colorado Engineering Council, headed by Dana E. Kepner, of 1921 Blake Street, Denver, Colorado.

The Institute of the Aeronautical Sciences is organizing a session of invited papers by Dr. W. R. Gregg, chief of the U. S. Weather Bureau, Colonel Edgar S. Gorrell, president of the Air Transport Association of America, Mr. Fred D. Fogg, director of Air Commerce, U. S. Department of Commerce, and Dr. Clark B. Millikan, of the California Institute of Technology. The session is tentatively scheduled for Tuesday afternoon.

The Section on Medical Sciences (N) will hold sessions on Tuesday, Wednesday, Thursday and Friday. On Monday morning there will be a joint program with the Southern California Section and the Pacific Coast Section of the Society for Experimental Biology and Medicine. Several excellent papers have been arranged for this program from the fields of physiological chemistry, physiology and psychiatry. Workers associated with the Childs Research Council will present a summary of their recent findings. The studies from this group have been of inestimable value to the pediatrician. The afternoon session on Monday will be held jointly with Section N_2, the Subsection on Pharmacy. Included on the program is a paper by F. E. Garlough, of the U. S. Biological Survey, dealing with the "Variation in the Response of Certain Birds and Mammals to Strychnine." This is one of a series of studies on the alkaloid, strychnine. Dr. Edward Jackson, professor emeritus of ophthalmology in the University of Colorado, will discuss "Physiology and Disorders of Equilibrium." It may be recalled that Dr. Jackson is the founder of the *Journal of Ophthalmology* and has been an outstanding leader in his special field for many years.

The programs on Tuesday, Wednesday and Thursday, which will extend from 10 o'clock to one o'clock, will be devoted to a "Symposium on Diseases Caused by Acid-Fast Bacteria." The Tuesday session will be of an introductory nature, in which the common bacterial, chemical and pathological characteristics of the members of the acid-fast group will be reviewed. The chief point in the meeting is to bring out the fact that all the acid-fast organisms, regardless of what disease they cause, have some characteristics in common. A number of distinguished workers will be represented on the program. Dr. Florence R. Sabin, of the Rockefeller Institute for Medical Research, will cover the subject from the point of view of cellular pathology. Dr. Sabin's outstanding contributions in this field are too well known to require further comment. There will be several papers in which groups of workers have combined in an effort to give as thorough a review of the subject as our present knowledge warrants. The combination papers are indicative of the cooperative spirit of scientific investigation in the various laboratories in the country. The sessions will be brought to a close by a general discussion, with Dr. Harry J. Corper in charge.

The second day of the symposium will be devoted to a consideration of specific diseases and is listed as "Tuberculosis and Other Animal Diseases of Acid-Fast Origin." The first paper, "Tuberculosis in Domestic Animals," by Dr. George W. Stiles, associate bacteriologist of the U. S. Bureau of Animal Industry, will be followed by a joint paper on the "Tuberculin Reaction in Cattle and No-lesion Reactions." Drs. William H. Feldman, Arthur B. Crawford and L. L. Daines will each cover certain phases of this general subject. The next topic will be a review by Dr. Joseph D. Aronson, of "Tuberculosis in Cold-Blood Animals." Dr. Aronson is particularly qualified to present this subject because of his exhaustive research in this particular field. "Johne's Disease" is a malady of cattle that has been extensively studied at Cornell University for many years, and Dr. W. A. Hagen will discuss this disease. The papers of this session will be summarized by Dr. William Charles White, chairman of the Committee on Medical Research of the National Tuberculosis Association.

Thursday will be turned over to the subject of "Leprosy," a condition universally associated with Hansen's bacillus. A program has been developed with the aid of the Medical Advisory Board of the American Leprosy Foundation (Leonard Wood Memorial) and promises to be of unusual interest. This is probably the first time an attempt has been made in the United States to bring together the outstanding American workers in this field. Following papers on "Geographical Distribution," "Epidemiology," "Bacteriology and Immunology," "Cultivation" and

"Institutional Segregation," Mr. Perry Burgess, president of the foundation, will close the symposium with a general discussion. Mr. Burgess's knowledge of leprosy as a world problem will be of great value in bringing together the various aspects of this disease.

The program on Friday will be opened by an address commemorating the work and life of Henry Sewall, a distinguished physiologist who died last year. This memorial address will be followed by a series of research and clinical papers dealing with various phases of human tuberculosis and diseases of the chest. The Colorado workers have arranged the program, and through Dr. James J. Waring, chairman of the committee on local arrangements, a cordial invitation has been extended to all who wish to visit the various departments of the Medical School to make their desires known and guides will be provided.

The Society for Experimental Biology and Medicine, Southern California and Pacific Coast Sections, will hold a joint session with the Section on Medical Sciences (N) on Monday morning. The program will consist of papers limited to ten minutes each.

The Section on Agriculture (O), in cooperation with the faculty of Colorado State College, will give a program of papers dealing with the scientific background of agricultural development in the Rocky Mountain region. This will include presentations of the geologic and edaphic characteristics of the area, water supply and related problems, range, horticultural and agronomic resources, each given by specialists within their respective fields. Sessions will be held on Wednesday afternoon and Thursday morning. On Friday and Saturday an agricultural field tour will visit the Colorado Agricultural Experiment Station at Fort Collins, the U. S. Department of Agriculture Horticultural Field Station and Dry Land Experiment Station near Cheyenne, Wyoming, and the Agricultural Experiment Station of the University of Wyoming at Laramie. Return to Denver will be via Rocky Mountain National Park. If desired, stops will be arranged at field projects of the Soil Conservation Service and the Resettlement Administration.

The Society of American Foresters will hold sessions during the period of the meeting. Opportunity will thus be afforded for contact and joint activity with the various sections and societies in which members of the society are interested. A program is being prepared that will feature some of the phases of forestry that are of national importance. This will take the form of a symposium on "Forests and Waters." Field trips will be arranged that will give an opportunity to see at first hand some of the problems and the work in forestry that are distinctive in this region. Many scenic and scientific attractions in the mountains of Colorado will repay visitors for their trip. This will be the first official visit of the society in the Rocky Mountains, and, accordingly, will offer many members the opportunity for exploration in virgin territory so far as forestry is concerned. Joint sessions will be held with the Section on Engineering (M) on Monday afternoon and with the Hydrology Section of the American Geophysical Union on Tuesday.

The Western Society of Soil Science, which regularly meets with the Pacific Division, will hold sessions at Denver on June 21 and 22.

The Section on Education (Q) has organized a special committee for the purpose of carrying out a strong and effective program. The local secretary for the section is Mr. Charles E. Greene, assistant superintendent of schools of Denver.

The National Social Science Honor Society, Pi Gamma Mu, will hold a luncheon on Thursday at 12 o'clock at the Cosmopolitan Hotel.

In conformity with the recently developed policy of the American Association of University Professors to hold regional conferences, one or two half-day sessions are being planned for the region which includes Colorado, New Mexico, Utah and Wyoming, in order to arouse a greater consciousness in teachers of the work being carried on by that organization. The program will include papers representative of both teaching and administration. It is hoped that President Carlson will take an active part. Although the meeting is being called as a regional one, it is hoped that all members attending the Denver meeting will join in making it a real success.

OBITUARY

MILTON JAY GREENMAN

WHEN a visitor to the Wistar Institute entered the office of the director, he found a genial, alert man, trained in biology, gifted to an unusual degree with mechanical and inventive abilities, with business capacity and good judgment, based on the imagination needed for an administrator. Thus Dr. Greenman was peculiarly fitted to bear his many responsibilities.

He died on April 7, in his seventy-first year, failing rapidly in the few weeks before his death—and the institute thus lost its real scientific founder, to the sorrow of all those associated with him.

In 1892 he graduated in medicine from the University of Pennsylvania, and became at once associated with Dr. Horace Jayne in the biological work at the university. In 1893 Dr. Jayne became director of the

Wistar Institute, and Dr. Greenman was associated with him as assistant director.

During this period he made a remarkable preparation of the bones of the human skeleton, which now forms an exhibition of these structures quite unequaled in detail and elegance.

On the retirement of Dr. Jayne, in 1905, he was made director of the institute. This brought him in direct contact with General Isaac J. Wistar, the founder of the institute, and under him he developed his business training.

Almost at once he began to consider the problems of the further development of the institute, which, in the earlier years, had grown more as a museum than as a center for investigation. Pursuing this idea, a group of ten anatomists was called in council, and a plan for the research work drawn up. This work began in 1906, and, with the aid of the Advisory Board formed from the original group of advisers, has continued ever since.

Following the purpose of making the institute helpful to the biologists of the country, Dr. Greenman began taking over the responsibility for the publication of a biological journal. The first experiment was made with the *Journal of Morphology*. Then, gradually, other journals were added until, at the present time, eight such journals have been acquired and are published, together with the bibliographic cards referring to them.

This step brought up the problem of printing, and through the generosity of a member of the board of managers, a suitable printing plant was established.

From the beginning of the laboratory work the albino rat had been used as the animal of choice. Large numbers of these had to be kept, and well kept. Here again, through the generosity of a member of the board, an adequate colony house was built for these animals, not only to furnish those used in the institute laboratories, but also to permit distribution to other laboratories working with these animals.

In 1916–17, Dr. Greenman turned aside for a time, to make two excellent studies on the nervous system of the rat. However, increasing executive duties prevented him from further work in this field.

The problem of the welfare of the rats was always before him, and to supply fresh food and pure water, a station was required in the country, where these conditions could be met. In 1928 this was accomplished by the establishment of the Effingham B. Morris Biological Farm, near Bristol, and about thirty miles from Philadelphia. Through the generosity of Mr. Morris, this station developed rapidly, furnishing buildings not only for laboratories, but for the culture of amphibians and for the rearing of the opossum—a project in which Dr. Greenman had been interested for many years. Thus was added a division of the institute which called for much administrative care. Here Dr. Greenman had his home.

He acted as secretary of the board of managers, who were his devoted friends and admirers, and it was through them that many activities not warranted by the resources of the institute were made possible.

Dr. Greenman has left behind him an unusual record of achievements directed to the advance of biology and of biologists the world over. His work will be long remembered.

HENRY H. DONALDSON

RECENT DEATHS AND MEMORIALS

DR. ELIAS POTTER LYON, professor of physiology at the University of Minnesota, who resigned last year as dean of the Medical School, died suddenly on May 4. He was in his seventieth year.

DR. CHARLES LINCOLN EDWARDS, since 1912 supervisor of the department of nature study of the Los Angeles schools, previously from 1894 to 1912 successively professor of biology at the University of Texas, the University of Cincinnati, Trinity College, Conn., and the University of Southern California, died on May 6. He was seventy-three years old.

DR. GEORGE HENRY FOX, formerly professor of dermatology at the College of Physicians and Surgeons, Columbia University, died on May 3 at the age of ninety years.

DR. ALBERT WILLIAM BORTHWICK, professor of forestry at the University of Aberdeen, died on April 19 at the age of sixty-four years.

IN the presence of five hundred persons, including members of the American Explorers Club and the American Polar Society, *The General A. W. Greely*, a three-masted schooner, in which a party of meteorologists under the leadership of Clifford J. MacGregor, of the Weather Bureau at Newark Airport, will sail for the Arctic on June 25, was christened on May 2 at Port Newark, N. J. Mrs. Gertrude Greely Sheed, a daughter of General Greely, after whom the ship was named, broke a bottle of champagne over the prow.

THREE trees were planted in front of the Franklin Institute of Philadelphia on May 1 in honor of Benjamin Franklin and two contemporary botanists, John and William Bartram. The trees, known as "Frankliniae Altamahas," were presented to the institute by Charles F. Jenkins, of Kitchen's Lane, Germantown. There were officially accepted at the ceremony by Henry Butler Allen, director of the institute. Miss Elizabeth C. White, of White's Bog, N. J., who has watched the growth of the young trees, and Arthur N. Leeds, of the Academy of Natural Sciences, also spoke briefly.

SCIENTIFIC EVENTS

THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

THE meeting of the International Council of Scientific Unions, which met this year for the first time in Great Britain, opened in London on April 26 with an informal reception by the president and fellows of the Royal Society. The delegates were received by Sir William Bragg, president of the society, and Dr. N.E. Nörland, of Copenhagen, delivered his address as president of the council. His subject was "The Figure of the Earth." Lectures were given by Sir William Bragg on "Classical Experiments made at the Royal Institution" and by Professor E. V. Appleton on "International Cooperation in Radio Research." On the following day an official reception was given by the University of London at which the degree of doctor of science was conferred on Dr. Nörland.

On April 27, Ramsay Macdonald, Lord President of the council, and Miss Macdonald received the delegates on behalf of the government at Lancaster House, and visits were made to the laboratories at the colleges of London University, research institutions, museums and the Broadcasting House. The sessions closed officially on May 3. The delegates were invited to attend the soiree of the Royal Society on May 4.

The International Council was established in 1919 to take the place of the International Association of Academies, which had lapsed during the war; it meets every three years, its membership being drawn from forty-two countries. The scientific unions, representing astronomy, geodesy and geophysics, chemistry, physics, scientific radio, geography and the biological sciences, present reports to the council at the time of the meeting, and during the three years interim pursue their activities as separate international bodies in affiliation with the council. At the meeting in London the Royal Society of Amsterdam proposed that a committee should be appointed to study what cooperation can be achieved in regard to the social responsibilities of science and scientific workers towards the dangers menacing the future of civilization. The council also had under consideration the report of the standing committee on the study of solar and terrestrial phenomena, and the report of the committee on the relations that should exist between the council and the Committee of Intellectual Cooperation of the League of Nations on matters concerned with international science.

THE BRITISH ASSOCIATION AT NOTTINGHAM

THE British Association for the Advancement of Science has issued a preliminary program of arrangements for the annual meeting, which will be held this year at Nottingham from September 1 to 8. According to an abstract of this program in the London *Times*, Professor Sir Edward Poulton, in his presidential address, will deal with the history of evolutionary thought as recorded in the meetings of the British Association.

In the sectional programs many of the subjects to be discussed have been marked for inclusion in the series dealing with science and the public welfare. Among them are the sex ratio, which Professor F. A. E. Crew will discuss in his presidential address to the Zoology Section; the changing distribution of population, with which Professor C. B. Fawcett will deal in his presidential address to the Geography Section, and the modern study of plants in relation to education, on which Professor E. J. Salisbury will speak in his presidential address to the Botany Section.

The informative content of education will be the subject of H. G. Wells's presidential address to the Educational Science Section. J. M. Caie will address the Agriculture Section on state intervention in agriculture. Noise and the nation will be the subject of the presidential address of Dr. G. W. C. Kaye to the Mathematical and Physical Sciences Section, and economic research and industrial policy of Professer P. Sargent Florence before the Economics Section. Tests in common use for the diagnosis of color defect will be dealt with by Dr. Mary Collins in her presidential address to the Psychology Section.

Among other subjects which have been included in the series are x-ray methods and industry, problems of labor transference, the contribution of physiology to the health of the individual and the community, adult education, the problem of costs of distribution, the human factor in industry, industrial physics, chemistry and building research, motor vehicles and road safety, physiology as a subject of general education, planning the land of Britain and vulnerability of the national power supply.

Other sectional presidential addresses include those of Dr. F. L. Pyman (Chemistry Section), on recent research in chemotherapy; Sir Alexander Gibb (Engineering Section), on research in engineering; Professor L. J. Wills (Geology Section), on the Pleistocene history of the West Midlands; Dr. J. H. Hutton (Anthropology Section), on Assam origins in relation to Oceania, and Dr. E. P. Poulton (Physiology Section), on metabolism, nutrition and growth in man—some new views.

THE EDGAR FAHS SMITH COLLECTION OF CHEMICAL MEMORABILIA

AN endowment fund of $50,000 for the maintenance and future development of the collection of chemical memorabilia assembled by the late Dr. Edgar Fahs Smith, formerly professor of chemistry and provost

of the University of Pennsylvania, has been established by Mrs. Smith. It was through her generosity that the collection was presented to the university following the death in 1928 of Dr. Smith.

Since its acquisition the collection has been housed in several rooms of the John Harrison Laboratory of Chemistry which were occupied by Dr. Smith for many years, but frequent additions to the original collection have made it increasingly difficult to exhibit it satisfactorily in its present quarters. Coupled with this factor is a desire on the part of the university to provide additional space for the convenience of a constantly increasing number of students from this country and abroad who come to consult it. As a result, it is planned to collect funds as part of the bicentennial campaign of the university for a chemical museum sufficiently large to accommodate the collection and to allow for its future growth.

The collection of more than 7,000 items contains books on alchemy and chemistry, many of which are in Latin, German and old French; autograph letters and manuscripts of distinguished chemists of all nationalities; portrait prints and engravings of chemists from the days of alchemy to the present, and chemical preparations and apparatus. Included also are many rare books and manuscripts relating to the early history of the University of Pennsylvania and to its alumni, faculty members and trustees who were prominent in national affairs.

The collection on the history of chemistry has grown to nearly 10,000 items as a result of frequent gifts. It includes a copy of the "Alchemy" of Geber, printed in Latin in 1545. The first edition of "The Truth and Antiquity of Chemistry" by Robert Vallensis, published in Latin in 1561, said to be the first attempt at a history of chemistry ever made, was given by Professor Walter T. Taggart, of the university. The "Theatrum Chemicum," compiled by Elias Ashmole and published in London in 1652, is represented by a copy in its original binding. Contained in this copy, which was once part of the library of Sir Isaac Newton and which still bears his book-plate, are the "Ordinall of Alchemy," by Thomas Norton, and a poem by Chaucer dealing with the mysteries of alchemy. The book-plate of Lord Cornwallis is found in a volume by Bomare, published in 1768. The autograph of Samuel Taylor Coleridge appears in Barchusen's "Elements of Chemistry" published in 1718. Of Boerhaave's "Elements of Chemistry" there is a copy of the 1732 edition which he personally autographed. Represented by letters and manuscripts bearing their signatures are Priestley, Pasteur, Madame Curie and others. There are also a large number of portrait prints and engravings of prominent chemists.

The collection crosses the borderline into medicine to Paracelsus and the iatro-chemists, and later into physics with Thomas Graham and others, one of the most recent acquisitions being autograph letters of Sir Oliver Lodge and Dr. Max Planck.

The Smith collection also contains autograph letters from ten signers of the Declaration of Independence—Robert Morris, Benjamin Franklin, George Clymer, James Wilson, Benjamin Rush, Thomas McKean, John Penn, Francis Hopkinson, William Paca and James Smith, all of whom were either trustees or alumni of the University of Pennsylvania. There are autograph letters from General Anthony Wayne and Tech Tilghman, graduates of the university.

THE BOTANICAL COLLECTIONS OF HARVARD UNIVERSITY

The Harvard Alumni Bulletin reports that a thorough renovation of the Arnold Arboretum in Jamaica Plain and the Harvard Botanic Garden in Cambridge has been under way during the past year.

Approximately 600 new shrubs and trees have been added to the permanent plantings of the arboretum, and extensive repairs made on the roads, paths and benches.

The grounds of the Botanic Garden have been thoroughly gone over and replanted. The growth about the Gray Herbarium building was removed, and replaced with selected shrubs from the arboretum. The old rock garden was torn up and a new one established, the overgrown iris plantings thinned out and reestablished on a new site, and the old area replaced with a lawn. The number of beds for annual and perennial plants was reduced, and the growing stock of the garden reinforced by shrubs from the arboretum.

The greenhouses were removed, and most of the plants sent to the Atkins Institution in Cuba, the roof greenhouses of the Biological Laboratory and the Bussey Institution. The remaining stock was given to the Massachusetts State College, Boston Teachers College, Wellesley College and the Boston Park Department.

Professor Elmer D. Merrill, administrator of the Harvard Botanical Collections, also says in his annual report that during the year the Arnold Arboretum distributed to other institutions 1,400 packages of seeds and scions and cuttings of 900 species and varieties of shrubs and trees. Accessions to the arboretum included 450 packets of seeds, 600 scions and cuttings and 1,900 plants.

The herbarium received important collections from China, Malaysia, India, Australia, Africa, Mexico, Central America and South America. These additions brought the total number of specimens to 430,000.

THE FIELD MUSEUM OF NATURAL HISTORY

THE annual report of the director of the Field Museum of Natural History, Chicago, for the year 1936 has been published. This is the last report of the late Stephen C. Simms, formerly director, who died on January 28.

The report opens with a statement calling attention to the financial needs of the museum. In 1936, and during several preceding years, the growth and development of the museum has been seriously menaced by decreases in nearly all sources of income. Returns from corporate securities in which endowment funds have been invested, from taxes levied for the maintenance of museums, from paid admissions, from fees paid for museum memberships and contributions received from public-spirited citizens, all have been far below former years and below the needs of the institution. If the museum is to carry on its expeditions, research and dissemination of knowledge and its services to the public of Chicago and the Middle West, increases in revenue must be obtained. Among the larger contributions received during the year were securities valued at $85,000 from Albert W. Harris, $74,626 from Marshall Field, of New York, and $59,882 from Stanley Field, president of the museum.

The number of visitors during 1936 was 1,191,437, representing a small increase over 1935, when attendance was 1,182,349. Of the total number of visitors, only 68,375, or less than 6 per cent., paid the twenty-five cent admission fee charged on certain days. The others came on free days or belonged to classes such as children, students and teachers, to whom admission is free.

The educational influence of the museum was extended by extra-mural activities directed principally toward reaching school children. One division of the museum, the James Nelson and Anna Louise Raymond Foundation, sent lecturers to 444 school assemblies. Traveling exhibits, circulated among 446 schools and other institutions through the Department of the N. W. Harris Public School Extension, reached approximately 700,000 children in public, parochial and private schools and in community centers. The spring and autumn lecture courses for adults, the Raymond Foundation's free-motion picture programs for children in the James Simpson Theater of the museum and the guide-lecture tours of the exhibits, attracted audiences of 78,711 persons. The library of scientific publications, which is open to the public for reference, was increased to approximately 105,000 volumes. Each of the scientific departments continued to provide collections of study specimens for use as reference material by teachers, students and others.

The report contains detailed accounts of new exhibits, accessions, research and other activities of the departments of anthropology, botany, geology and zoology and the various other divisions of the museum. There is also a complete list of its 4,238 members.

THE MEDAL MEETING OF THE FRANKLIN INSTITUTE

THE medal meeting of the Franklin Institute of Philadelphia will be held on Wednesday afternoon, May 19, at 3:30 P. M. As has already been reported in SCIENCE, the Franklin Gold Medal and certificate of honorary membership will be awarded to Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics and chairman of the Executive Council of the California Institute of Technology, and to Dr. Peter Joseph Wilhelm Debye, director of the Kaiser Wilhelm Institute of Physics, Berlin.

The Franklin Medal is awarded annually from the Franklin Medal Fund, founded on January 1, 1914, by Samuel Insull, "to those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the institute, acting through its Committee on Science and the Arts, have done most to advance a knowledge of physical science or its applications."

The award is made to Dr. Millikan "In recognition of his isolation and measurement of the fundamental unit of electricity, the electron; the photoelectric determination of the fundamental constant of radiation, Planck's constant; the extension of the ultra-violet spectrum by two octaves to join the spectrum of soft x-rays; and the study of the nature and the properties of a very penetrating radiation of cosmic origin."

Dr. Debye will receive the medal "In recognition of his fundamental conception and masterly development of the theory that the molecules of many substances possess permanent dipole moments—a theory of great value in stimulating a vast amount of fruitful research on the electrical properties of insulators; his extension and generalization of Einstein's theory of the specific heats of solids, and his work, in collaboration with Huckel, on a theory of the thermodynamic properties of electrolytic solutions, work upon which the whole modern theory of electrolytes is based."

In addition to the Franklin Medal the following medals will be awarded:

The Longstreth Medals: Emile Monnin Chamot, Ph.D., professor of chemistry, Cornell University; Richard T. Erban, consulting engineer, New York City; John S. Haug, consulting gas engineer, United Engineers and Constructors, Inc., Philadelphia; Harold Sinclair, director, Hydraulic Coupling and Engineering Company, Ltd., England; Herbert L. Whittemore, chief, Engineering Mechanics Section, National Bureau of Standards.

The Henderson Medal: Rupen Eksergian, Ph.D., E. G. Budd Manufacturing Company, Philadelphia.

The Levy Medal: Inge Lyse, professor of engineering materials, Lehigh University.

The Potts Medal: John Clyde Hostetter, Sc.D., vice-president, Hartford Empire Company, Conn.

The Cresson Medals: Carl David Anderson, Ph.D., California Institute of Technology; William Bowie, Sc.D., LL.D., United States Coast and Geodetic Survey (retired); Jacques Edwin Brandenberger, Neuilly-sur-Seine, France; William Francis Giauque, Ph.D., University of California; Ernest Orlando Lawrence, Ph.D., director, Radiation Laboratory, University of California.

An address will be presented on behalf of Dr. Millikan, who is unable to attend the ceremonies, by Dr. Carl D. Anderson, of the California Institute of Technology, on "Exploring the Stratosphere for New Electrical Effects." Dr. Debye's address on "Structure in Electrolytic Solutions" will be presented by Dr. Charles P. Smyth, of Princeton University.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM H. PARK, founder of the public health laboratories of New York City, received the George M. Kober Medal from the Association of American Physicians on May 5 at the closing session of its fifty-second annual convention at Atlantic City. It was announced that next year the medal will be awarded to Dr. Rufus Cole, director of the Hospital of the Rockefeller Institute, New York.

DR. JAMES F. NORRIS, professor of organic chemistry at the Massachusetts Institute of Technology, has been awarded the annual medal for notable service to science and chemistry of the American Institute of Chemists. The medal will be presented to Dr. Norris on May 15 at the annual dinner of the institute. The award was made in recognition of "outstanding service as a teacher and as an investigator in the field of organic chemistry."

THE Pennsylvania Society of New York has awarded its Medal for Distinguished Service to Dr. Victor G. Heiser, from 1914 to 1927 director for the Far East of the International Health Board of the Rockefeller Foundation, and from 1927 to 1934 associate director of the International Health Division of the foundation. The award was made in recognition of the medical research carried out by him under the auspices of the foundation.

AT the annual dinner of the National Institute of Social Science, New York City, on May 11, one of the gold medals of the society was presented to Dr. James Rowland Angell, president of Yale University, "in recognition of services rendered in the interest of scholarship and education; because of distinction in psychology, and as a truly distinguished educator."

A DINNER in honor of Dr. William F. Durand, emeritus professor of engineering at Stanford University, was given on May 7 by alumni in San Francisco. Mr. Herbert Hoover was chairman of the committee arranging the dinner.

FIVE members of the National Association of Science Writers, all of whom have reported the meetings of the American Association for the Advancement of Science for many years, shared the $1,000 Pulitzer award for 1937. The award, "for the most distinguished example of a reporter's work, "was given in recognition of their accomplishments in connection with the tercentenary celebration of Harvard University. The criteria on which the award is made are "strict accuracy, terseness, the preference being given to stories prepared under the pressure of edition time that redound to the credit of journalism." Those sharing the award are: Howard W. Blakeslee, Associated Press, *president;* William L. Laurence, *The New York Times, vice-president;* David Dietz, Scripps-Howard Newspapers, *past president;* Gobind Behari Lal, *Universal Service,* and John J. O'Neill, *The New York Herald-Tribune.*

A WHITE pine tree was planted at Warrensburg, N. Y., on the Charles Lathrop Pack Demonstration Forest on May 7, by the New York State College of Forestry at Syracuse, N. Y., to celebrate the eightieth birthday of Charles Lathrop Pack, president of the American Tree Association. This tree will be a companion to the George Washington tree planted in front of the rustic lodge along the main highway running north and south between Lake George and Montreal. It will be planted by Dean Samuel N. Spring, Professors Ralph T. King and Svend Heiberg, with the assistance of the director of the Pack Forest, Clifford H. Foster. Mr. Pack, the donor of several college forests, has given two forests to the New York State College, one of 1,000 acres on the shores of Cranberry Lake, and one of 2,250 acres, three miles north of Warrensburg.

THE Medal of the British Society of Chemical Industry, presented every alternate year "for conspicuous service to applied chemistry," has been awarded to Professor G. G. Henderson, regius professor of chemistry in the University of Glasgow. The medal was awarded in recognition of original research—mostly in the organic field, particularly the chemistry of terpenes—and of the supervision of the research work of students.

M. P. Lebeau, professor of pharmaceutical chemistry in the University of Paris, has been elected a member of the Academy of Sciences, Institute of France, to take the place of the late M. H. Le Chatelier.

Dr. Heinrich Wieland, professor of chemistry at Munich, has been elected a corresponding member of the Physico-Mathematical Section of the Prussian Academy of Science.

The degree of doctor of laws will be conferred in June by the University of Glasgow on Dr. Jan Boeke, professor of histology and embryology at the University of Utrecht; on Dr. Max Planck, emeritus professor of theoretical physics at the University of Berlin; on Sir Albert Charles Seward, emeritus professor of botany at the University of Cambridge, recently master of Downing College, and on Sir Robert Muir, emeritus professor of pathology at the University of Glasgow.

Dr. Edwin G. Conklin, of Princeton University, was elected president of Science Service, at its annal meeting on April 29. Dr. J. McKeen Cattell had made known his desire not to be reelected after nine years in the presidency, but continues as a member of the board of trustees, on which he has served continuously since Science Service was founded in 1921. The trustees and staff of Science Service joined in honoring Dr. Cattell at a dinner on April 28. Dr. W. H. Howell, of the Johns Hopkins University, was reelected vice-president and chairman of the executive committee, while Harry L. Smithton, of Scripps-Howard Newspapers, was reelected treasurer. Dean Carl W. Ackerman, of the Graduate School of Journalism of Columbia University, was added to the board of trustees.

At the recent meeting of the American Society of Biological Chemists at Memphis, Tenn., the following officers were elected: *President,* G. E. Cullen, University of Cincinnati; *Vice-president,* W. C. Rose, University of Illinois; *Secretary,* H. A. Mattill, University of Iowa, and *Treasurer,* A. B. Hastings, Harvard University. Additional members of the council are: J. B. Collip, H. B. Vickery and H. B. Lewis.

At the fourth annual meeting of the American Institute of Nutrition, held in Memphis on April 21, the following officers were elected: *President,* Mary Swartz Rose; *Vice-president,* E. V. McCollum; *Treasurer,* George R. Cowgill; *Secretary,* Icie G. Macy; *Councilors,* C. A. Elvehjem, L. A. Maynard and Paul E. Howe.

At the annual meeting of the Missouri Public Health Association, recently held in Springfield, the following officers were elected: *President,* Dr. Edwin H. Schorer, health director, Kansas City, Mo.; *President-elect,* Dr. M. P. Moon, associate professor of bacteriology (medical) and preventive medicine, University of Missouri; *Secretary,* Dr. John W. Williams, assistant state health commissioner; *Treasurer,* L. E. Ordelheide, sanitary engineer, St. Louis County.

Retirements at the University of California at Berkeley are announced as follows: Dr. Henry R. Hatfield, professor of accounting on the Flood Foundation; Dr. W. L. Jepson, professor of botany; Dr. Derrick N. Lehmer, professor of mathematics; Dr. C. C. Plehn, Flood professor of finance; Dr. Charles A. Noble, professor of mathematics; Charles E. Rugh, professor of education, and Dr. Joseph N. LeConte, professor of mechanical engineering.

Members of the faculty of the University of Minnesota who will have reached the age of retirement—sixty-eight years—at the close of the present academic year include: Dr. J. B. Johnston, dean of the College of Science, Literature and Arts; William H. Kirchner, professor of drawing and descriptive geometry in the Institute of Technology; Professor Josephine E. Tilden, of the department of botany; Dr. Edgar D. Brown, associate professor of pharmacology in the Medical School; Professor Everett W. Olmsted, head of the department of Romance languages, and Miss Marion Weller, of the department of home economics.

Dr. Kenneth F. Maxcy, who recently retired as professor and head of the department of preventive medicine and public health of the School of Medicine of the University of Minnesota, has been appointed professor of bacteriology at the School of Hygiene and Public Health of the Johns Hopkins University, effective on July 1. He succeeds Dr. William W. Ford, who has held the position since 1920 and is retiring on account of the age limitation. Dr. Maxcy accepted the directorship of the International Health Division of the Rockefeller Foundation in January.

Professor Linus Pauling has been appointed to succeed the late Professor Arthur A. Noyes as director of the Gates Chemical Laboratories of the California Institute of Technology.

Dr. Emmerich Von Haam, for the past six years assistant professor of pathology at the Louisiana State University, has been made chairman of the department of pathology of the College of Medicine of the Ohio State University. He will take up his new work on July 1. The department has been administered by Dr. Carl L. Spohr as acting chairman since the death of Dr. Ernest Scott in 1934.

At Columbia University, Dr. Sam F. Trelease has become Torrey professor of botany, and Dr. Edward Kasner, Adrain professor of mathematics, both by change of title. Dr. Jerome J. Morgan has been pro-

moted to a full professorship of chemical engineering, and Dr. Jan Schilt has become Rutherford professor of astronomy and director of the Rutherford Observatory.

DR. THEODORE GEORGE BENTLEY OSBORN has been appointed to the Sherardian chair of botany of the University of Oxford.

DR. RUDOLPH PEIERLS, at present assistant-in-research at the Mond Laboratory of the Royal Society at Cambridge, has been appointed to the newly established chair of applied mathematics at the University of Birmingham.

DR. ALBERT R. MANN, since 1931 provost of Cornell University, has been elected vice-president and director for southern education of the General Education Board. He had been dean of the New York State College of Agriculture from 1917 to 1931 and of the State College of Home Economics since its establishment in 1925.

DR. JAMES ROWLAND ANGELL, retiring president of Yale University; Dr. Livingston Farrand, retiring president of Cornell University, and Lewis W. Douglas, formerly director of the United States Budget, were elected members of the board of trustees of the American Museum of Natural History at a meeting of the trustees held on May 3.

BANCROFT GHERARDI, vice-president and chief engineer of the American Telephone and Telegraph Company, has been elected a trustee of Cornell University, to fill the unexpired term of the late Robert H. Treman.

M. A. CARRIKER, JR., of the department of ornithology of the Academy of Natural Sciences of Philadelphia, and Gordon Howes, of Toms River, N. J., sailed on April 24 for South America to continue their study of bird migration in Bolivia.

DR. HERBERT S. GASSER, director of the Rockefeller Institute for Medical Research, gave on May 12 a lecture entitled "Nerve Fibers" before the Yale Medical Society.

DR. A. J. CARLSON, of the University of Chicago, spoke on "Science and the Common Life" at the annual public meeting of Phi Beta Kappa on May 5 at Newcomb College, Tulane University.

THE fourth general assembly of the International Union for the Scientific Investigation of Population Problems will meet in Paris on July 28 in connection with the International Population Congress, organized by the French National Committee, which takes place from July 29 to August 1. The Population Association of America, through its Research Committee, which is also the American National Committee of the International Union, is sending a number of delegates to attend the assembly and the congress. The delegates, most of whom will present papers, are as follows: O. E. Baker, Joseph V. De Porte, Harold F. Dorn, Louis I. Dublin, H. P. Fairchild, Carter Goodrich, Norman E. Himes, Clyde V. Kiser, C. E. Lively, Frank W. Lorimer, Alfred J. Lotka, Frank W. Notestein, Frederick Osborn, Raymond Pearl, Frederick F. Stephan, S. A. Stouffer, Warren S. Thompson, Leon E. Truesdale, P. K. Whelpton, Robert M. Woodbury and T. J. Woofter, Jr. Adequate representation of American scholars on this occasion has been made possible by a grant of $2,500 from the Milbank Memorial Fund and a grant of equal amount from the Carnegie Corporation of New York, towards the expenses of the delegation.

THE twenty-third annual meeting of the American Association of Cereal Chemists will be held under the presidency of H. D. Liggitt, Jr., from May 24 to 28 at the Nicollet Hotel, Minneapolis. Among those appearing on the program are: Dr. Alonzo E. Taylor, director of the Food Research Institute of Stanford University and chairman of the research committee of General Mills, Inc., Minneapolis; Dr. D. Breese Jones, of the U. S. Department of Agriculture; Dr. C. W. Brabender, of Germany, and Dr. D. Jordan Lloyd, of the British Leather Manufacturers Association.

DISCUSSION

THE INTERNATIONAL WHO'S WHO

THE second edition of the international "Who's Who" (London, 1937) is a valuable work of reference containing brief biographical sketches of about 19,000 persons considered by its editors to be of "international prominence." The general make-up follows the lines familiar in the American "Who's Who." The numerical representation of the hundred countries included ranges from 3,150 for Great Britain and 2,650 for the United States down to single units for several of the small countries. Women are represented by 1.6 per cent. of the total number of names, while the percentage for Great Britain is 2.8 and for the United States is 3.6.

The distribution among the principal countries is as follows:

	Per cent.		Per cent.
Great Britain	16.7	Czechoslovakia	1.7
United States	14.0	Austria	1.6
France	9.1	Switzerland	1.6

Germany	8.2	Yugoslavia	1.6
Italy	3.7	Norway	1.5
Sweden	3.3	Soviet Republic	1.5
Japan	2.6	South Africa	1.4
Denmark	2.3	Belgium	1.3
Hungary	2.2	India	1.3
Canada	2.2	Roumania	1.2
Netherlands	2.1	Spain	1.2
Australia	2.1	China	1.1
Poland	2.1	Finland	1.1

The distribution among the more important occupations for the British and U. S. Americans is as follows:

British	Per cent.	U. S. Americans	Per cent.
Politics	29	Science	23
Business	13	Writing	17
Writing	12	Law	10
Science	11	Business	10
Art	6	Politics	7
Law	5	Finance	6
Medicine	4	Art	6
Theology	3	Education	5
Finance	3	Engineering	4
Diplomacy	3	Medicine	3
Military	3	Diplomacy	3
Education	2	Theology	2
Engineering	2	Military	1
Trade Unions	2	Trade Unions	0.3

There is some overlapping, as, for example, politics and law. Administrative officials are included under politics. For the Americans, science includes economics with 99 names, chemistry 50, physics 46, astronomy 41, geology 40, philology 35, social science 32, biology 30, botany 30, zoology 26, mathematics 22, psychology 22, and others.

Of the U. S. Americans who attended more than one college or university, 610 attended two, 200 attended three and 110 attended four or more institutions of learning. On the other hand, there are 420 who do not list any college education. There are 1,170 who have the doctor's, 150 the master's and 400 the bachelor's degree. Americans attending foreign institutions of learning numbered 610, and 240 foreigners, mostly Chinese and Canadians, attending American institutions. The number of persons attending the various American colleges and universities is as follows:

Harvard	437	Wisconsin	83
Columbia	290	California	55
Yale	222	Mass. Inst. Tech.	52
Chicago	157	George Washington	46
Princeton	114	N. Y. Univ.	43
Johns Hopkins	113	Virginia	41
Cornell	96	Illinois	35
Michigan	85	Indiana	35
Pennsylvania	85	Stanford	33
Nebraska	30	Amherst	16
Naval Academy	29	Georgetown	16
Brown	28	N. Y. Law School	16
Minnesota	28	Ohio Wesleyan	16
Northwestern	26	Washington	16
Williams	26	Vanderbilt	15
Iowa	24	Wesleyan	15
Military Academy	23	Cincinnati	14
Ohio	22	Pittsburgh	14
Boston	21	Clark	13
Missouri	21	Hamilton	12
Texas	21	Colorado	11
Dartmouth	19	Tulane	11
Kansas	19	DePauw	10
City College of N. Y.	18	Maryland	10
Oberlin	18	Washington and Lee	10
N. Carolina	17		

There are 300 other institutions represented by less than ten names each.

The distribution among the principal sciences for the British and Americans is as follows:

British (Total of 336 names)	Per cent.	American (Total of 605 names)	Per cent.
Chemistry	14	Economics	16
Economics	12	Chemistry	8
Physics	8	Physics	8
Philosophy	8	Astronomy	7
Mathematics	7	Geology	7
Archeology	6	Philology	6
Social Science	5	Social Science	5
Physiology	4	Biology	5
Philology	4	Botany	5
Astronomy	4	Zoology	4
Geology	4	Mathematics	4
Geography	3	Psychology	4
Ornithology	3	Political Science	3
Anthropology	3	Philosophy	3
Botany	3	Archeology	2
Psychology	3	Anthropology	2
Zoology	3	Physiology	2
Mineralogy	2	Meteorology	2

FRANK B. LITTELL

WASHINGTON, D. C.

"HOMING" OF PACIFIC SALMON

IN a recent communication[1] Professor A. G. Huntsman questions the evidence for the "homing" of salmon, *i.e.*, the return to the "natal river from a distant place in the sea." While I can not speak from experience in respect of the Atlantic salmon I feel very confident that the Pacific salmon of the genus *Oncorhynchus* do return to their home streams from long distances at sea and that comparatively few are "lost" and enter streams other than those whence they came.

If we accept as absolutely essential to satisfactory

[1] SCIENCE, 85: 313-314, 1937.

proof the criteria set up by Professor Huntsman it must be admitted that complete evidence is lacking. He states, in effect, that it is necessary to prove "for the individual fish" not only that it has returned to its home stream, but that it has been far from the "zone of river influence" of that stream. I should like to add that it would also be necessary for completely rigid proof that the evidence be quantitatively adequate to satisfy the requirements of statistical significance. So far as I can see such rigid observational proof could only be provided by marking young fish in their "natal river," recapturing them in the sea at a point sufficiently distant to satisfy every one that the fish was beyond the "zone of river influence," tagging or marking them at that point and again releasing and, finally, to recapture them a second time in their "natal river." Needless to say, it will be some time before much such proof will be accumulated.

I think, however, that the logic of the situation is such that we need not demand such practically impossible evidence before we can say with considerable assurance that salmon do return predominantly to their native streams from whatever distance they may go in the sea. There is ample evidence, both observational and statistical, of intraspecific racial segregation in the Pacific salmon.[2] The development and maintenance of such races could not take place if there were much intermingling of the population groups on the spawning grounds. That there is some such intermingling no one would deny; but it can not be extensive in most cases and is probably confined chiefly to races inhabiting streams not widely separated. If there is not extensive intermingling of races on the spawning grounds can we say, then, that the individuals belonging to these races do not range at sea beyond the limits of "river influence"?

I do not think so. We know that very large numbers of fish do enter streams hundreds of miles from the point of tagging[3] and under conditions that warrant the assumption that the fish are well beyond the range of "river influence"—so far, at least, as has yet been determined by hydrographic studies. But there is no evidence of such wholesale admixture of races as would result if these large numbers of salmon were indeed "lost" so that they would enter any stream within the influence of which they happened to wander. If they were so lost it would seem impossible that the fish spawning in different streams could be so racially distinct as they often are even in nearby tributaries of a single river system. The simplest theory that will adequately explain all these facts is that the salmon do return predominantly to their home streams.

[2] Numerous publications during the years 1912 to 1933 by C. H. Gilbert, W. A. Clemens, J. O. Snyder, W. H. Rich and others in *Bull. U. S. Bur. Fish.*, *Reports Commr. Fish. for Brit. Columbia* and *Calif. Fish and Game and Fish Bulls.*

[3] C. H. Gilbert and W. H. Rich, *Bull. U. S. Bur. Fish.*, 42: 27–75, 1925; W. A. Clemens, *Prog. Repts. Pac. Biol. Sta., Biol. Bd. Can.*, 4: 11–13, 1929; A. L. Pritchard, *ibid.*, 8: 15–20, 1931.

Perhaps one of the difficulties is due to the use of the word "instinct" with reference to "homing" and "migration." "Instinct" need not imply, although it usually does, a reaction involving factors that are not susceptible to scientific study and analysis; it need only mean that the factors have, as yet, not been determined. It can not be doubted that some kind or kinds of gradients serve to guide the salmon, as with all other migrating animals, on their journeys. These gradients may be those more obvious ones associated with "river influence" or some as yet unrecognized gradients in the ocean.

Important practical problems in the conservation of the Pacific salmon are involved because laws and regulations have been based upon the theory that the salmon do return to their home streams for spawning and the corollary that the populations in the different streams are independent and self-perpetuating. It is to be hoped that the doubt cast by Professor Huntsman upon the validity of this theory on account of the lack of complete observational proof will not affect the present general acceptance of the theory and of the obvious requirements of conservation that it demands.

WILLIS H. RICH

STANFORD UNIVERSITY

GLASS GLOBES ON THE PACIFIC

THE glass globes mentioned in SCIENCE for February 12, 1937, p. 179, evidently float northeastward, as well as across the Pacific. We of last summer's Hrdlička expedition to the Aleutians found eight or nine of them on the northwestern shore of Kiska Island, latitude fifty-two degrees; between 177 and 178 longitude, east.

SYDNEY CONNOR

JUNIOR SCHOOL BUILDING
GIRARD COLLEGE, PHILADELPHIA

LINES OF INHERITANCE IN FAMILIES OF "BLEEDERS" AS NARRATED IN 1834

IN view of the date of publication an article from which I quote below may be of interest to students of Mendelism. It is entitled "Extraordinary Bleeders." It was published in 1834 in a "History of Ipswich, Essex and Hamilton, Mass.," by Joseph B. Felt.

> There are four families in this town (Hamilton) called bleeders. Three of these are immediately and the other mediately, related. The number of individuals so denominated is five. They are thus named from an unusual propensity in their arteries. . . . Some of their predecessors have come to their end by wounds which are not

considered by any means dangerous for people in general. This hemorrhage first appeared in the Appleton family, who brought it with them from England. *None but males are bleeders, whose immediate children are not so, and whose daughters, only, have sons thus disposed.* As to the precise proportion of these, who may resemble their grandfathers, in bleeding of this kind, past observation furnishes no data.

The italics are mine.

GEORGE E. LADD

CHEVY CHASE, MD.

QUOTATIONS

THE MELLON INSTITUTE

THE formal dedication of the Mellon Institute's huge new building, a temple of science in outward appearance and inward spirit, is an event of national magnitude. And properly so when it is recalled that the institute has served some 4,000 firms, developed 650 processes and products and created ten new industries since Andrew W. Mellon and the late Richard B. Mellon founded it in 1911. The new structure is a monument not only to the generosity and far-sightedness of the two brothers who made it possible but of the late Professor Robert Kennedy Duncan, who conceived the industrial research fellowship system which has been such a brilliant success.

When the small manufacturer hears of the millions spent annually for research by great companies he wonders how long he will last—wonders how he, without even a testing laboratory, can compete with trained crews of Ph.D.'s hired to improve yarns, telephones, lamps, radio sets, tins for foods and foods themselves. The Mellon Institute is his salvation. Here for a few thousand dollars science doffs its coat, rolls up its sleeves, solves his problem, creates values for him, and what is more important, opens his eyes to the rich return that research pays.

Though this social aspect of the work done in accordance with Robert Kennedy Duncan's policy needs to be stressed, it would be wrong to regard the Mellon Institute merely as an industrial life preserver. As a non-profit-making enterprise it plows back for the public good the excess moneys that may not remain in its bank account. So we find it concerning itself with more than skinless frankfurters, soapless soaps, flaked coffee, shoes that can be polished merely by rubbing a cloth over them, razor blades, unbreakable dishes of new plastic compounds. It draws on its own scientific and financial resources to solve the problem of smoke and dust, to arrive at better ways of diagnosing tuberculosis, to study methods of treating pneumonia, to illuminate the dark subject of dental decay. Nor is it unmindful of its obligation to advance science as such. Its work in theoretical chemistry and biology, for which new facilities are provided, promises to be even more distinguished in the future. Under Drs. Robert Kennedy Duncan and Raymond Bacon, and latterly under Edward R. Weidlein, the institute has become not only the technical first-aid of big and little business, but a training school for future laboratory directors, an experiment station for the advancement of science, a clearing-house of information for the public. As such it deserves not only the good wishes and congratulations of the manufacturers whom it has served, but of a wider public that may not be fully aware of its high place in industry and science.—*The New York Times.*

SCIENTIFIC BOOKS

THEORY OF SOUND

Vibration and Sound. By PHILIP M. MORSE. New York: McGraw-Hill Book Co., 1936, pp. xv + 351, $4.00.

THE outstanding advances in acoustics during the last two decades have been made chiefly in physiology and in engineering rather than in the physics of sound. Most of the recently published books on the subject have reflected this trend, but this one by Professor Morse is written almost entirely from the point of view of the classical physicist. It emphasizes the physical principles underlying all engineering applications.

I have used the term "classical" advisedly, as from a casual reading of the announcement of the book one might get the quite erroneous impression that at least certain phases of the subject are treated by quantum mechanics. While it is true that some acoustical phenomena, such as the abnormal attenuation of sound in gases discovered by Knudsen, can not be satisfactorily explained without resort to quantum physics, these particular matters are not discussed.

A study of this book does, however, reveal that there is an interesting parallel in the relationship between electrical engineering and acoustics, on the one hand, and wave mechanics and acoustics, on the other hand. To the beginning student the general principles of electrical circuit phenomena are most easily explained by means of acoustical analogies, but in the electrical engineering art there have been developed theories and formulae covering many combinations of circuit elements with which the practicing engineer has become much more familiar than with the theories relating to

corresponding mechanical and acoustical systems. Because of this familiarity, it has become the custom to describe various acoustical phenomena in the language of the electrical engineer by reference to corresponding electrical circuits. In presenting the principles of wave mechanics, Schroedinger and subsequent expositors of the subject made use of acoustical analogies, showing particularly the similarity in the problems of finding the allowed energy levels in atomic physics and the normal modes of vibration of mechanical and acoustical systems. Because of the extraordinary interest in atomic physics in recent years, the former class of problems has become more familiar to the theoretical physicist than the latter. In this book, therefore, some of the mathematical techniques used in wave mechanics and particularly the idioms which there have become familiar are applied to problems in acoustics.

The book deals most particularly with those parts of acoustics to which the mathematical methods used in wave mechanics are especially applicable, that is, those in which normal modes of vibration are determined from a differential wave equation and the boundary conditions and in which the resulting motion under a given force is determined by expansion of the force in a series of terms characterizing the normal modes of motion. The extent to which this method of treatment dominates the discussion throughout the book is indicated by the fact that nothing or little is said about velocity potential, the dynamical equations of Lagrange or the principle of reciprocity. The author devotes considerable space at the beginning of the book to the vibrating string, as this is admirably adapted for priming the student in the mathematical methods used in most of the succeeding chapters, which deal with bars, membranes, plates, radiation, propagation and scattering of sound, speech and hearing, and the acoustics of rooms.

The engineer may not find this book entirely convenient if he is looking for information of the kind which is customarily given in engineering handbooks. Some of the notation, which is often at variance with that adopted by the American Standards Association, may be unfamiliar to him, *e.g.*, ν is used instead of f for frequency and a clockwise instead of the conventional counter-clockwise rotation of the positive time vector is adopted. On the other hand, the student who wishes to become thoroughly grounded in certain methods of the theoretical physicist as applied to acoustical problems and at the same time to obtain a comprehensive picture of the physical relationships involved, will here find an excellent introduction. Although the discussion throughout the book is based on well-established principles, the presentation is refreshingly original as well as clear. A set of well-chosen, illustrative problems is given at the end of each chapter.

It has long been customary to consider the problems in the acoustics of rooms from the standpoint of wave propagation and the mean free path of the wave. This method has been fruitful in dealing with practical problems. More recently a number of investigators have studied the subject analytically by the more conventional methods of mathematical physics whereby the normal modes of vibration together with their periods and rates of decay are determined from the field equation and the boundary conditions. This is the method of treatment adopted in this book. Although it may not as yet have been of great direct help in the acoustical design of rooms because of the difficulty of obtaining even an approximate solution of the equations in practical cases, it is extremely valuable in that it affords a clear physical picture of the nature of the acoustical phenomena in rooms. The discussion by Professor Morse is, I think, more illuminating than anything presented heretofore from this point of view.

The particular forms of the apparatus and instruments chosen as examples for the application of the mathematical methods are not of a kind that have come into commercial use, nor perhaps of a kind that any one should want to build for purposes of study. They apparently have been idealized to illustrate more effectively the points the author wishes to emphasize. This procedure is in line with the whole plan of the book, which is to discuss and bring out those principles that are physically fundamental to the science rather than to give a description of things which may be here to-day and gone to-morrow.

E. C. WENTE

SPECIAL ARTICLES

FUNDAMENTAL THEOREMS OF TRIHORNOMETRY

(1) A *horn angle* is the figure formed by two curves having a common tangent at a common point. Only the case of first order contact is considered here. The unique conformal invariant of a horn angle I have shown to be

$$M_{12} = \frac{(\gamma_2 - \gamma_1)^2}{\dfrac{d\gamma_2}{ds_2} - \dfrac{d\gamma_1}{ds_1}}$$

where γ represents curvature and s arc length. This combination of the two curvatures and the two rates of curvature is therefore called the *natural measure* of the horn angle. It is a real abstract number.

Since only first order contact is allowed, the measure M_{12} can not be zero, but can be infinity. If M is infinite, the horn angle can be reduced conformally to the circular (or Euclidean) case—a circle and a tangent line. If M is finite, the horn angle can be reduced to the parabolic (or Appolonian) case—a parabola and a line tangent to it at a point that is not its vertex.

For convenience, the curvatures are represented by x and the rates of curvature by y. Then, $M_{12} = (x_2 - x_1)^2/(y_2 - y_1)$. An *auxiliary plane* in which x and y are represented as cartesian coordinates is introduced. The horn angle is represented by two points (x_1, y_1), (x_2, y_2), and M_{12} is their distance in the new metric. Obviously $M_{21} = -M_{12}$.

(2) A *trihorn* is formed when three curves have a common tangent at their common point (but do not have higher contact at this point). A trihorn has six measures: M_{12}, M_{21}, M_{23}, M_{32}, M_{31}, M_{13}. These are evidently connected by the following relations:

$$M_{21} = -M_{12},\ M_{32} = -M_{23},\ M_{13} = -M_{31}.$$

We select M_{12}, M_{23}, M_{31} as the three principal measures of the three horns of the trihorn.

Besides, a trihorn has six new angles: α_{12}, α_{21}, α_{23}, α_{32}, α_{31}, α_{13} which are conformally invariant. Each α-angle measures the angle between two horns and may be called a dihorn angle. The angle α_{12} is defined in the auxiliary plane as follows:

$$\alpha_{12} = \alpha_{3,\,12} = \alpha_{31,\,32} = \frac{(y_2 - y_3)/(x_2 - x_3)}{(y_1 - y_3)/(x_1 - x_3)}.$$

Therefore,

$$\alpha_{21} = \frac{1}{\alpha_{12}},\ \alpha_{32} = \frac{1}{\alpha_{23}},\ \alpha_{13} = \frac{1}{\alpha_{31}}.$$

Select α_{12}, α_{23}, α_{31} as the three principal angles of the trihorn. In the auxiliary plane, the trihorn is represented by a (rectilinear) triangle; the M's are the *sides* of the triangle, and the α's are the *angles*.

We now state the following theorems on *trihornometry;* some are analogous to theorems in ordinary trigonometry, and some are strikingly different.

I. A necessary condition that three numbers be the measures of the sides of a trihorn is

$$M_{12}\, M_{23}\, M_{31}\ (M_{12} + M_{23} + M_{31}) \leqq 0$$

If M_{12} and M_{23} are positive, so also is M_{13}, and we have $M_{12} + M_{23} \geqq M_{13}$. In this sense the sum of the parts is usually greater than the whole, but may be equal to the whole. In the exceptional case of equality we call the trihorn *wide-open.*

II. The absolute values of the three measures are equal if and only if all are infinite. If two of the measures are infinite, the third measure is infinite; the trihorn is then said to be completely circular or euclidean.

Except for these peculiar cases, and the case where the M's are equal in absolute value, the condition

$$M_{12}\, M_{23}\, M_{31}\ (M_{12} + M_{23} + M_{31}) \leqq 0$$

is sufficient for three numbers to be the measures of a trihorn. If $M_{12} + M_{23} + M_{31} = 0$ the trihorn is *wide-open.* The three points in the auxiliary plane are then collinear.

III. The α angles of a trihorn obey the relation $\alpha_{12}\,\alpha_{23}\,\alpha_{31} = 1$. This a fundamental *equality,* instead of *inequality,* as for the sides.

IV. If one and only one side of a trihorn is infinite, one of the adjacent angles of the trihorn is zero, another is infinite, and the third angle (opposite the infinite side) is finite and non-zero. The third angle has two possible values if the sides are given. (Such a trihorn is partially circular.)

V. If one of the angles of a trihorn is infinite (then, it follows, one of the sides is infinite), another angle is zero and the third is finite and non-zero.

VI. If the three measures of a trihorn are infinite (completely circular) the angles are all indeterminate.

VII. If one of the angles of a trihorn is indeterminate, then all the angles are indeterminate and the three measures are infinite.

VIII. If a trihorn is wide-open and not circular, the three angles are unity.

IX. If one of the angles is unity, all the angles are unity and the trihorn is wide-open.

X. Except for unit, zero, infinite and indeterminate values, the equality $\alpha_{12}\,\alpha_{23}\,\alpha_{31} = 1$ is a sufficient condition for three numbers to be the angles of a trihorn.

XI. If the three sides of a trihorn are given, two values of the angles are determined; that is two distinct (non-congruent) triangles exist. The trihorns are conformally distinct.

XII. If the three angles of a trihorn are given, the ratios of the three sides are uniquely determined. If any three parts, except the three angles, are given, all the parts are determined (with one or two solutions). (The detailed formulas, all algebraic, will be given elsewhere).

XIII. Neither equilateral nor equiangular triangles exist.

XIV. If two sides of a triangle are equal, the opposite angles are never equal.

XV. A triangle can have two right angles, but not three.

XVI. In any isosceles triangle, the sum of the base angles is unity.

XVII. A *right angle* has the value $\alpha = \frac{1}{2}$, and an *anti-right angle,* the value $\alpha = 2$. The minimum distance is given by the former value. The perpendicular and the anti-perpendicular distances between two parallel lines are in the ratio of $-8:1$.

XVIII. The medians of a triangle (mid-points correspond to the bisectors of the horns of the trihorn) are concurrent; but the altitudes are not concurrent.

XIX. The congruence group in the new metric is $X = mx + h$, $Y = m^2y + k$.

(4) In conclusion, I remark again that only horn angles of first order contact are allowed in the preceding discussion. If higher contacts are permitted, the theory becomes much more complicated (since each order requires a new theory of measure), and the complete conformal geometry of horn angles becomes *non-Archimedean.* The fact that angles of contact of different orders are not metrically comparable was first noted by Newton in the Principia.

EDWARD KASNER
COLUMBIA UNIVERSITY

UPWARD TRANSPORT OF MINERALS THROUGH THE PHLOEM OF STEMS

THE general opinion among botanists is that the mineral elements absorbed by the roots are transported upwards in the xylem with the water. Curtis[1] as a result of his numerous investigations has, however, suggested that at least some of the soil solutes ascend in the phloem. Mason and Phillis[2] dispose of the matter of solute conduction by the statement: "To sum up, ringing experiments have shown that soil solutes ascend the stem in the wood, but they have not demonstrated that they (soil solutes) may not also ascend in the phloem. It must be admitted, however, that the evidence available renders it very unlikely that they normally do so."

With a new tool available, namely, strongly radioactive elements, we have undertaken to clarify this issue. The installation of the new cyclotron equipment in the physics laboratories at the University of Michigan has made available fair quantities of strongly radioactive material. Phosphorus was chosen because it is an important element in every plant and because its half life is fifteen days, a period long enough to allow one to conduct several experiments with the same preparation. Red phosphorus was activated and then made into KH_2PO_4. This salt was made up into a 0.5 per cent. aqueous solution with a pH of 5 to 6. Rooted cuttings of geranium, *Sedum praealtum* and *Bryophyllum calycinum* have been used as plant material. These plants were chosen because the bark separates readily from the wood. The presence of the radioactive phosphorus in the plant was detected by means of an electroscope.

[1] O. F. Curtis, "The Translocation of Solutes in Plants." McGraw-Hill, 1935.

[2] T. G. Mason and E. Phillis, "The Migration of Solutes." *Bot. Rev.*, 3: 47–71, 1937.

As more details will later be published elsewhere, only a few experiments will be cited here. With *Bryophyllum* several experiments were performed in which part of the bark with several leaves was completely separated from the wood except at the base, and at this point the remainder of the plant was cut off. This left the plant with only a few leaves attached to the bark, which was connected with the roots through a portion of the unmutilated stem. In one of these experiments the piece of bark was 22 cm long and had four leaves attached to it.

The roots of this plant were kept in the active phosphorus solution for about 40 hours. At the end of this period the leaves were still quite turgid. The bark was cut up into pieces 2 cm long and the activity determined. Table I gives the results for this experiment. The electroscope discharged itself in 40 minutes, so that any time less than 40 minutes denotes active phosphorus in the plant material.

TABLE I
TIME REQUIRED TO DISCHARGE THE ELECTROSCOPE WITH 2 CM-LONG PIECES OF BRYOPHYLLUM BARK

Distance above solution, cm	Time in minutes
3	13.0
7	16.0
11	19.25
15	22.5
17	25.0
19	30.0
23	38.0

This shows that even in the last section, which was 23 cm above the solution, there was some radioactive phosphorus present. In this experiment the leaves were not tested, but in others where tests were made, active phosphorus was found to be present in them also.

In another group of experiments with *Bryophyllum* a complete section of the xylem, about 2 cm long, was removed from the stem, leaving the leaves connected with the roots only through the bark, which was left complete. In one of these experiments a well-rooted plant remained in an active phosphorus solution for 17 hours. Table II gives the results.

TABLE II
TIME REQUIRED TO DISCHARGE THE ELECTROSCOPE WITH 2 CM-LONG PIECES OF BRYOPHYLLUM STEM (SECTION OF WOOD REMOVED)

Distance above solution, cm	Bark	Xylem underneath bark
6	8.0 min.	20.0 min.
8	14.0 "	Wood removed
10	25.0 "	35.0 min.
13	32.8 "	39.5 "

There is evidence here that phosphorus was conducted through the phloem of the *Bryophyllum* stem

and that some of this diffused into the xylem above the cut. A considerable quantity of the active element must be present before detection is possible by the electroscope.

To determine what may be the amount of active phosphorus in a plant with intact xylem as compared with one that has the xylem removed, experiments were performed with *Sedum praealtum*. The wood was removed from one plant, as in the *Bryophyllum*, and another similar plant with xylem intact was selected as control. The two plants were placed in the same solution and in one experiment kept there for 40 hours. They were both cut up at the same time, sections taken at the same levels and the quantity of active phosphorus determined alternately. Table III gives the results.

TABLE III

TIME REQUIRED TO DISCHARGE THE ELECTROSCOPE BY 2 CM-LONG PIECES OF SEDUM PRAEALTUM STEM

Distance above solution, cm	Phloem		Wood and pith	
	exp. plant	*control*	*exp. plant*	*control*
3	19.0 min.	15.5 min.	26.0 min.	19.0 min.
7	21.0 "	17.25 "	wood removed	
11	26.75 "	20.25 "	32.0 min.	24.25 "
15	30.0 "	26.5 "	35.5 "	29.0 "
19	38.0 "	32.5 "	39.0 "	37.75 "

The difference in quantity of active phosphorus, level for level, between the two plants is remarkably small.

Experiments with well-rooted geranium cuttings have also been performed. The results are essentially the same as for *Sedum*.

These experiments show beyond a doubt that the radioactive phosphorus, in form of phosphate, is transported up the stem of a plant through the phloem.

The writers take this opportunity to express their thanks to Professor J. M. Cork, of the Physics Department, for his kindness in supplying them with the radioactive material, and also to Miss Alice Huse for her help with some of the preliminary experiments.

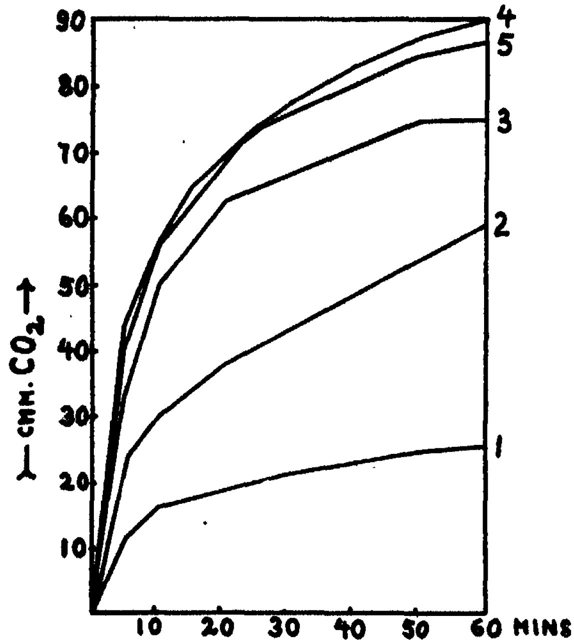
FELIX G. GUSTAFSON
MARJORIE DARKEN

DEPARTMENT OF BOTANY
UNIVERSITY OF MICHIGAN

SYNTHESIS OF CO-CARBOXYLASE FROM VITAMIN B_1

IF synthetic, crystalline vitamin B_1 is treated in the cold with phosphorus oxychloride in a molecular ratio of at least 1:2, *a compound is formed exhibiting the properties of co-carboxylase.*

The activity of the synthetic co-enzyme of carboxylase is tested in a system containing bottom yeast freed from natural co-carboxylase by extensive washing, pyruvic acid as the substrate, and magnesium as activator. The carbon dioxide formed by decarboxylation of the substrate, as determined in Warburg manometers, serves as the measure of activity. Up to the present the yield of synthetic co-carboxylase, as judged from the comparison with boiled yeast juice, has not exceeded 1.5 per cent. of the theory. The same results have been obtained using crystalline, synthetic vitamin B_1 preparations from two different sources,[1] one prepared by the synthesis of Williams and Cline[2] and the other by that of Andersag and Westphal.[3] A typical experiment is shown in the figure.



The main room of the Warburg vessels (total volume about 17 cc) contained 1 cc of washed dry yeast (*cf.* Lohmann and Schuster[4]), corresponding to 100 mg dry weight, varying amounts of synthetic co-carboxylase or boiled yeast juice, and 0.1 M. phosphate buffer, pH 6.2, to make a volume of 3 cc. After attainment of equilibrium there were added from the side bulbs of the vessels 0.3 cc of sodium pyruvinate solution, pH 6.2, equivalent to 5 mg pyruvic acid, containing 0.1 mg magnesium as $MgCl_2$. In addition to the foregoing, vessel No. 2 contained 0.2 cc of boiled yeast juice, corresponding to 20 mg of bottom yeast, vessel No. 3 contained 0.3 cc, vessels No. 4 0.9 cc, and vessel No. 5 1.8 cc of the synthetic co-carboxylase preparation No. II (1 cc equivalent to 2.2 mg vitamin B_1 hydrochloride). Vessel No. 1, containing only yeast suspension and buffer in the main room, served as the control. Atmosphere: Air; temperature 28°.

[1] The authors are indebted to Merck and Company and to the Winthrop Chemical Company for the supply of synthetic vitamin B_1.

[2] R. R. Williams and J. K. Cline, *Jour. Am. Chem. Soc.*, 58: 1504, 1936.

[3] Andersag and Westphal, cited by R. Grewe, *Zeits. physiol. Chem.*, 242: 89, 1936.

Lohmann and Schuster[4] report that natural co-carboxylase, isolated in highly purified form, from bottom yeast, represents a diphosphoric ester of vitamin B_1. The thiochrome pigment prepared from co-carboxylase differs from that obtained from vitamin B_1 by its phosphorus content. Cataphoretic experiments performed on the thiochrome derived from our synthetic product indicate that ester formation with phosphoric acid has occurred. The present experiments thus offer additional proof for the validity of the results of Lohmann and Schuster.

Attempts to effect a transformation of vitamin B_1 into co-carboxylase by tissue extracts (liver, brain, intestine) have as yet not been successful.

KURT G. STERN
JESSE W. HOFER
YALE UNIVERSITY, SCHOOL OF MEDICINE

AN ACCESSORY PHOTOSENSITIVE SUBSTANCE IN VISUAL PURPLE REGENERATION

KÜHNE'S discovery of the regeneration of visual purple in solution[1] has recently been confirmed and investigated quantitatively.[2] In repeating some of the measurements it was observed that in solutions bleached with a photoflood lamp the subsequent regeneration was greater than in those bleached by an ordinary 100-watt lamp, although the visual purple had completely disappeared in both cases. Because the photoflood lamp emits much energy in the blue, this suggested the existence of a blue-sensitive substance whose decomposition was essential for visual purple regeneration. If this is the case, visual purple solutions bleached by violet and blue light should show much more regeneration than solutions bleached by green, yellow and orange light. This turns out to be true, and an experiment illustrating it will now be described.

Two mutually exclusive parts of the spectrum were secured by passing the light from a heat-screened photoflood lamp on 110 volts either through a yellow filter (Corning No. 350) or through a blue one (Corning "lantern blue" No. 554). Tests showed that these two lights were almost equally effective in bleaching visual purple. A freshly prepared visual purple solution buffered at pH 7.7 was divided into two parts. One was illuminated with the blue light 10 cm away for 30 minutes, which was three times longer than necessary to bleach the visual purple completely. Its photometric density ($\log I_0/I$) in a 5 mm absorption cell was measured at 500 mμ during the next 30 minutes in the dark, in the course of which the density increased by 0.0330. The other identical sample was similarly treated with the yellow light; its density increased only 0.0037 in the same time. To show that the yellow-bleached solution was nevertheless capable of more regeneration, it was then illuminated for 10 minutes with the blue light and its density again measured during 30 minutes in the dark. This time there was an increase in density of 0.0330. (The precise agreement is obviously accidental.)

The density was also measured at 450 mμ during these manipulations, and showed that the yellow-bleached sample had decreased considerably in density during its 10-minute exposure to blue. Apparently, the marked regeneration found at 500 as well as at 450 mμ occurred only after this density decrease in a blue-absorbing substance had taken place.

Whether this photolabile blue-absorbing substance is present in the unbleached visual purple solution or is a product of visual purple break-down is not decided by these data. Dr. E. L. Smith of this laboratory has suggested that it may be a flavin and is investigating this possibility at present. It is also uncertain whether the new material plays a primary rôle in vision in the same sense that visual purple does, or is important only for the resynthesis of visual purple in the dark.

The visual purple extractions which gave these results were obtained from winter frogs by the procedure that has already been described.[1] The photometric density measurements were made with a very sensitive photoelectric spectrophotometer designed by Dr. Simon Shlaer. The work was aided by a grant from the Rockefeller Foundation.

AURIN M. CHASE
LABORATORY OF BIOPHYSICS
COLUMBIA UNIVERSITY

[4] K. Lohmann and Ph. Schuster, *Naturwiss.*, 25: 26, 1937.

[1] A. Ewald and W. Kühne, *Unters. aus dem physiol. Inst. der Universität Heidelberg*, 1: 267, 1878.

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THE DEDICATION OF THE NEW BUILDING OF MELLON INSTITUTE[1]

INTRODUCTORY REMARKS AND COMMENTS

By Dr. E. R. WEIDLEIN

DIRECTOR OF THE INSTITUTE

Honorable Andrew W. Mellon, Mr. Richard K. Mellon, distinguished guests, friends of Mellon Institute and friends of our radio audience: We extend to you our sincere appreciation for your presence. We are stimulated by an audience of leading scientists, educators and industrialists, who are here to pay tribute to our founders in dedicating this magnificent new building to science for the benefit of humanity. In this we all take pride; and as that occasion has now approached, let me say a word about the meaning of the institute and about the purpose of its founding.

Before they established the institute in 1913, Andrew W. Mellon and the late Richard B. Mellon, the father of Richard K. Mellon, saw the merit of scientific research for the benefit of mankind through the development of industry. Industries of that day, however, were not applying scientific research for the solution of their problems, nor were these industries fully aware as to what such research might mean to them. The institute was established for the purpose of giving this aid.

This venture of scientific research very soon proved its value. New materials and new processes came into being. Industries and the whole estate of man benefited. Yet the founders saw beyond these results. It seemed to them that there were needed researches in science that have a more direct relation to human welfare, which might also advance our basic knowledge of science. Such fundamental work was started; and

[1] Pittsburgh, Pa., May 6, 1937.

the entire program through these many years has been sustained with generosity by the founders.

The institute has become a guild of scientists. Here are gathered many men trained in chemistry, biology, physics and engineering. They help one another directly; and, even more important, they create an atmosphere of achievement for themselves in which there grow vision and determination for thorough, careful work. Their success is not accidental. It is the outcome of strong minds and of orderly thought, of good will and of good teamwork, of seeking toward a great end. Even the founders did not entirely foresee the results to be attained by such a guild, nor did they anticipate, in the days of the beginning, the full values to humanity which would flow from such researches.

As one who has had association with the founders through many years, their quiet, unpretentious guidance of the institute has deeply impressed me. Richard B. Mellon has gone. He had the satisfaction, however, of seeing the four walls of the new building completed. He was happy to watch the columns go into place; and he was happy, too, that he was regarded as a member of the guild. His courage, his patience and his imagination qualified him as a great and always to be honored member.

Of Andrew W. Mellon it is more difficult to speak, for he is here. His mind always proceeds through details to the final significance, and he seems never to be disheartened. These qualities of mind as a background to the endless discouragements and elusive headway of scientific research can be understood, it seems to me, best by one who has lived through large experience with such difficulties.

Their contribution is a noble gift to humanity.

We are delighted to have with us to-day the Honorable Andrew W. Mellon, whose sincere desire to make America the best place in this world in which to live and prosper has been the motive back of all his philanthropic contributions. I know that all of you join with Mellon Institute to-day in the pleasure of greeting our eminent founder, the Honorable Andrew W. Mellon.

ADDRESS OF THE HONORABLE ANDREW W. MELLON

The building being dedicated to-day realizes the hopes of many years. My brother and I had long looked forward to this occasion and it would have made him very happy if he could have seen, during his lifetime, the completion of this beautiful building for the Mellon Institute. I wish, too, that Dr. Robert Kennedy Duncan could have lived to see this day and the institute's many activities, for he was, in the beginning, at least, the inspiration of it all.

The manner in which it came about was quite unpremeditated, as those things often are. Strange as it may seem, it all goes back to a school of languages and a quite innocent desire on my part to speak French fluently enough to travel abroad in comfort—a desire, I may add, which remains unsatisfied to this day. At any rate, I called on the school for help, and they sent a young Frenchman to my house in the evenings during the summer of 1909. He was a very enthusiastic young man, and one night he brought a letter from his father in France who had made a chemical discovery, as he thought, and wanted it tested by some industry in a position to utilize the discovery commercially.

I gave the letter to the chief chemist of the Gulf Oil Company, who reported a few days later that the supposed discovery was not of practical value, and, to prove it, gave me a book, just then published, called "The Chemistry of Commerce," by Robert Kennedy Duncan, professor of chemistry at the University of Kansas. I read the book with interest, but the part which particularly enlisted my attention was the last chapter, in which Dr. Duncan described his plans for industrial fellowship, by means of which industry could utilize the services of qualified scientists to solve its problems, in much the same way as is being done here to-day.

After pointing out the confusion and waste in manufacturing, most of which was chemical, not mechanical, he went on to say that with larger combinations of capital and a new generation of business men becoming aware of the possibilities of the new knowledge, improvements were coming and would continue to come in industry as the aid of science was invoked to solve the problems constantly arising.

I was very much interested in these ideas of Dr. Duncan's, for as a result of all my reading and observation it seemed to me that improvement in the standard of living of the human race could come about in the future only by reason of new discoveries and inventions, just as, in the past, the steam engine and other inventions had been responsible for many improvements in the standard of living enjoyed by the average man to-day. It was these things, and not governmental or political action, that had increased production, lowered costs, raised wages, elevated the standard of living and so had brought about a greater participation of the human race in these benefits.

It seemed to me that an institution based on Dr. Duncan's ideas could help in this advance movement; and as my brother was keenly interested in the project, we lost no time in persuading Dr. Duncan to come to Pittsburgh and organize for us here at our university this Institute of Industrial Research. It em-

braces, as you know, not only chemistry but biology, for chemical research frequently develops biological discoveries also; and so it seemed fitting to cover both fields in this new and, at that time, unique institution.

Dr. Duncan became our first director and at his untimely death a few years later, just as the then new building had been completed, his assistant and close associate, Dr. Weidlein, took his place and has ably carried on the work, with the happy results of which you and all the world know. Those results speak for themselves and are the best proof, if any is needed, that an institution of this nature, organized and conducted along the lines Dr. Weidlein has projected, and with the facilities provided for the application of chemistry to industry, fills a useful and important place in modern life. The measure of the institute's success is the increasing volume of fellowships which have been established as the value of work currently accomplished has been demonstrated.

I can not praise too highly all that Dr. Weidlein has done in developing this institution and making it a factor of such constructive value in the life of this country, and, I may say, of the world, for science fortunately has no national boundaries and new discoveries in any country eventually benefit all mankind.

I have been very happy to have a part in this work and feel it has been a great privilege for my brother and me to provide this place where men of science can come in their search for new ways to increase the usefulness of industry, to promote health and so improve the common lot of all. It is science, not governments or wars of conquest, that open to us new horizons; and, as Dr. Duncan so truly said, the new processes and new powers which science will discover will in the future give man the chance to live and to live more abundantly. If this institute can contribute, even in small measure, towards this end, all of us here today can feel that our efforts will not have been in vain.

Mr. Mellon has paid a worthy tribute to Dr. Robert Kennedy Duncan, whose idea, courage and enthusiasm have carried through our organization to this day. "Nothing great," Emerson said, "was ever achieved without enthusiasm." The men engaged in research work at Mellon Institute have this quality to a marked degree, and I can assure you, Mr. Mellon, that your message will add to their courage and determination to succeed. They deserve all the credit for the accomplishments of the institute. This modern building with its majestic columns is the culminating step toward the dream of your brother, Richard B. Mellon, and yourself—the vision of a greater institute beautifully and efficiently housed, in keeping with the character of these scientists' contributions to humanity and to science.

Mr. and Mrs. Richard B. Mellon always were builders, not only of institutions but also of character. These excellent qualities are reflected in their children, Mr. Richard K. Mellon and Mrs. Sarah Scaife. They, together with their mother, have continued the work of Richard B. Mellon. It is impossible to name any worthy measure that has made for civic uplift and benefit in Pittsburgh that has not had the direct friendly assistance of the late Mr. Mellon. His son is a worthy successor and I am honored to present to you Mr. Richard K. Mellon, who represents his father and family. Mr. Mellon.

ADDRESS OF RICHARD K. MELLON

Honored guests and ladies and gentlemen: Well do I recall the opening of the first permanent building of the Mellon Institute in February, 1915. On that occasion I accompanied my father and mother and some classmates from Shadyside Academy. Of course, it was a rather interesting evening for us, but as I reflect, I realize that we younger fellows hadn't the slightest conception of what future developments were to bring forth, or what was contained within the walls of that former building. I am quite sure that none of us appreciated what knowledge of science meant to industry and business at large.

I was fortunate enough in those years to overhear at home the two brothers, my uncle and my father, discuss many times with the late Dr. Robert Kennedy Duncan, and later with Dr. Weidlein, the current findings and future possibilities in the field of scientific research. As time passed, I had an opportunity to become well acquainted with the various events that took place in the progress of industrial research. Those discoveries seemed rather thrilling at that time, as chemical warfare was taking such a prominent part in the great war. Following that period there was a tremendous expansion in industry in this country, as you all know, and it was during this era that research departments were started by corporations of all sizes and kinds.

Following this post-war expansion period came depression, and it is surprising to know how many industries survived on their research findings alone. Many of the products of manufacturing plants at the present time were conceived during the past few years. It has been said, and I think rightly so, that research in this country is responsible in a large degree for our present high standard of living.

When it is realized that there are more than 1,600 industrial research departments associated with nearly every line of industry, the recognition that is given to scientific findings can readily be seen. All these companies have their own particular problem and are at work seeking a solution that will advance their par-

ticular product. In other words, their research is directed in a particular direction forward; but under one roof scientific effort is centered, and because of this, each fellowship is given a broader vision of what is being undertaken by other people in diversified lines.

A general feeling seems to prevail that this is a scientific chemical laboratory, aiding only industry. This is not entirely true, and we can well realize the reason for the misunderstanding. Scientists are so shy about their work that very little is ever published regarding their efforts. The fellows of Mellon Institute are constantly at work doing pure research in the field of biology and have been quite successful in their discoveries. Many lives have been already saved as the result of the individual effort of these fellows, and it is the hope of the founders that they will continue their research in the biological and related fields. Too much praise can not be given them, and I know that they regard success as their chief reward.

This memorable occasion gives me much pleasure, and, at the same time, brings sadness. We had hoped that one of the founders, my father, would have been here with us to participate in this dedication, and it is a disappointment also that his lifelong partner, my mother, had to be absent to-day. They both followed so carefully the progress which the institute has made and enjoyed watching the construction of this beautiful building. Mother has done much to add to the cheerfulness of the interior. We are happy indeed and keenly delighted that the one original founder, the Honorable Andrew W. Mellon, is here to participate in to-day's ceremonies.

Acting in behalf of the founders, I have the honor to say that they have complete confidence in the future under the able guidance of its present director. He has had marked success in the administration of the multiple duties that have confronted him, and keenly appreciates the tasks that are ahead of him. It is a pleasure, at this dedication ceremony, to hand the key of this new building to Dr. Edward Ray Weidlein, director of the Mellon Institute.

Honorable Andrew W. Mellon and Mr. Richard K. Mellon, on behalf of the trustees, executive staff and fellows of Mellon Institute, we accept the great responsibility that you have placed in our charge. These new and unusual facilities for research, in the fields of both pure and applied science, will strengthen our position to add to the comfort, convenience, health, safety, happiness and prosperity of mankind. We wish to express to you our most cordial appreciation for all that you have done for us.

[Dr. Weidlein introduced the guest speakers, who made addresses as follows: Dr. Irving Langmuir on "Chemical Research"; Dr. Harold C. Urey on "The Accomplishments and the Future of Chemical Physics"; and Dr. W. P. Murphy on "Scientific Research in the Solution of Medical Problems." Dr. Weidlein called attention to the circumstance that the speakers were Nobel laureates and made a statement concerning the establishment of the Nobel prizes.]

Long before ideas of the physical form of Mellon Institute's new home had crystallized, two definite decisions were made: First, to fulfil its essential purpose, the building must be the most advanced scientific workshop that modern knowledge could provide. Secondly, it must be beautiful as a tribute to science and to the institute's own achievements—appropriate to the ideals of its founders and in keeping with the imposing architecture of companion buildings in Pittsburgh's civic center.

Although other types of architecture were considered, the preference from the outset was weighted heavily in favor of the Grecian school. The architecture of ancient Greece combines great beauty with the simplicity that is fitting to a home of science. And in the philosophy and the general intellectual curiosity of the Greeks of the golden age, modern science had its beginning. The architecture of the building, therefore, was to be a tangible recognition of the link between the science of early days and the science of the present and future, exemplified in the institute's purpose and work.

It is a fitting climax in our dedication to thank all the skilled workmen as well as the contractors who have converted the thoughts and ideas of the architects and engineers into this beautiful structure. Mr. Alexander Howie and his workmen deserve special mention for their skill in setting the stonework and especially for their unusual engineering ability in putting the columns in place. The total weight of all 62 monolithic columns, including bases and capitals, each with an over-all height of more than 42 feet, is 4,432 tons: here is the largest monolithic column installation in the world. They did not even put a scratch on a single column. We also wish to thank our general contractors, Mellon-Stuart Company, for their splendid work.

The greatest credit goes to the architects, Janssen and Cocken, who were able to take our needs for arrangement and space and to design such an artistic and practical building. In this outstanding work they were aided constantly and faithfully by our own staff engineer, Mr. Harry S. Coleman, who has become the leading expert in this country on laboratory design, and we are proud of him.

Several parts of the new home of the institute have been inserted with symbolic meaning, to render the art

therein emblematic of the purpose of the institution, the beneficence of science, the origin and advancement of chemistry and the value of industrial research. This symbolism was devised by Dr. William A. Hamor, of the institute's executive staff, in cooperation with Janssen and Cocken.

In closing this memorable occasion, I wish to acknowledge with thanks the loyal support which the institute has received from Mr. Henry A. Phillips, our treasurer and a trustee, who has guided us successfully to the completion of the building. We are also grateful to Dr. John G. Bowman, chancellor of the University of Pittsburgh, who has had a very important part in the development of the institute. We maintain close cooperation with the University of Pittsburgh and are deeply appreciative for the splendid support of that institution.

Then, again, let me express our thankfulness to our founders for this splendid institute, which they have created, and, to quote from Dr. Murphy's address, "let us hope that, with the help of men trained in such an institution as this one, the results of research may produce even greater happiness, health and a longer and more efficient life than is now possible."

ROBERT KENNEDY DUNCAN[1]

By Dr. B. T. BROOKS
NEW YORK, N. Y.

It is impossible to return to Mellon Institute without feeling that the influence of Robert Kennedy Duncan is alive and is a vital force here to-day, even though there are very few of the fellows here who were here when he was alive. It is appropriate to speak of his character here, because I believe that in many respects the character of Robert Kennedy Duncan is the character of Mellon Institute to-day.

I wish that I had his wonderful gift for expression, his beautiful diction. In speaking of the character of Dr. Duncan I feel a great responsibility, since I am for the moment the mouthpiece for those who knew him well and loved him. I do not presume to give you an appraisal of his character. In my opinion the professional biographers who have attempted to psychoanalyze great men have generally done a very poor job of it. And so I shall speak only of a few of the traits of Dr. Duncan's character which most impressed me, and if I omit other qualities which may have greatly impressed others, I admit that the fault is entirely mine and plead also that lack of time prevents making this picture of him as complete as I would like.

There were several outstanding traits of character which I believe could not fail to impress any who were associated with him. These traits were what I term his complete honesty of purpose; second, his great courage and intelligent audacity, and, third, his human qualities. Speaking of Dr. Duncan should not cast a moment's shadow on this very happy occasion. The atmosphere here is in some respects like the celebration of a victory, a victory which was planned by him, together with Mr. Andrew W. Mellon and Mr. Richard B. Mellon, who understood Duncan and his purposes. There is, I think, another element in this celebration which I can only describe as something which warms the heart, and which I associate with those human qualities of Duncan's, and which I believe has come down through the years with those who understood him and have carried on.

Some of you may wonder how all this achievement represented by the new Mellon Institute and its splendid record of past performance has come about. Was it merely that Duncan had conceived a plan of practical cooperation between science and industry, or was it merely that the Mellons had anticipated the New Deal and were seeking for ways to spend money regardless of result?

No, I think it required more than wise planning and resourcefulness to have accomplished what has been done. I believe that one key to the mystery, one cardinal element which made all this possible, was the character of Robert Kennedy Duncan.

It is always interesting to examine the career of a great man and try to discover the more or less hidden clues to his success. In Duncan's case it would be trite to say that he inspired confidence and had rare qualities of leadership.

I assure you that the quality of leadership is still a great deal of a mystery, like genius, and is the subject of a great deal of inquiry. We still debate or privately wonder as to whether or not such great leaders as Jeanne d'Arc or Abraham Lincoln were not really more than mere human clay. We find the rare combination of qualities that we vaguely call leadership in utterly different types of men. Several years ago the American Engineering Societies made a study of the elements conducive to success among engineers. The opinion expressed by the vast majority of about sixteen thousand questionnaires placed character above all other essentials. Some of our military authorities from a study of great military leaders, and failures, have come

[1] Address delivered at the trustees' dinner in connection with the dedication of the new building of Mellon Institute.

to the same conclusion, but the term character alone does not tell us much.

I have mentioned Duncan's complete honesty of purpose. One could not fail to sense this, as Burke said in his great speech on the conciliation of the American Colonies—"Plain honest good intention is as easily perceived as its opposite." Polonius, in Hamlet, uses the phrase, "by indirections find directions out." This was never Duncan's method, and I am told that the confidence of Andrew Mellon and Richard B. Mellon in Dr. Duncan dated from their first interview with him. This quality was of immense value in his leadership when director of the Mellon Institute, since all of us felt that whatever he requested of us must be right. I am sure that this quality impressed industrialists and has led to the establishment of many a research in Mellon Institute entirely aside from other considerations. One day he said to one of the fellows: "Boy, you have discovered something that may be quite valuable to another fellowship and I am going to ask you to give it to them. Understand, you have every right to it and it may seem to you that there is no justice in my request, but, you know, the fellow who is always seeking justice never gets it and is always in hot water." Honesty of purpose is certainly one of the foundation stones of Mellon Institute.

I have often asked myself what his views would have been regarding some of the political and economic feuds of to-day. He would have deplored the class hatreds that are now so rampant. Envy was not in him. He believed there was room for everybody, with work and the possibility of gracious living for all. He often said, "Never be afraid of too much research. We are only spooning up the ocean."

If labor leaders and employers generally had Duncan's point of view, how much easier it would be to settle labor disputes. Barring those cases where passion has been raised, I am sure Duncan could have settled any labor dispute in spite of the fact that he had little of the judicial calm and patience usually supposed to be necessary to adjust such disputes. His pulse beat fast. He was capable of strong emotion and was full of nervous energy; but with his directness and honesty of purpose I know he would have won where too much so-called tact would only have aroused suspicion.

We all found out, after a time, something of what his greater purposes were. He thought deeply of our economic future, and while he would not have proposed that the fullest cooperation of science and industry would be a panacea for all our ills, we did know that this plan was directed toward a future when every one would be able to live fuller, richer and more purposeful lives. How much more rational to attain the more abundant life through the cooperation of science and industry than through experiments with the law and political hocuspocus.

One great quality of Duncan's was his intelligent audacity. This quality is absolutely essential to leadership. People will follow a man who only seems to have this quality regardless of other considerations. Duncan's intelligent audacity was shown by the originality of his industrial fellowship plan, and the intelligence and soundness of the plan is fully attested by the dedication ceremonies in which we are here to participate. His intelligent audacity was also shown by his prophetic statements in his book, "The Chemistry of Commerce," as to what industrial research would achieve. Many of the major prophecies which he made at that time have since been fulfilled. This quality of audacity is generally associated with youth, but it is not always so, and I believe Duncan, at eighty years of age, would have shown enough courage and audacity to have qualified him as a Democratic nominee for the Supreme Court.

It has been pointed out that all Napoleon's marshals became conservative and slow with twenty added years. It was feared at Richmond in 1861 that Lee was too old and that he would be too conservative, but one of his closest friends said that he was one of the most daring men in the army and that Audacity was his middle name. No one ever expressed such views after the campaign of the Seven Days. Barrie in his essay on courage, which he delivered when installed at St. Andrews, spoke of the days when as a cub reporter he lived in a little back hall bedroom, and said, "Those were the days!" of high courage. Yet the elderly Barrie at St. Andrews had evidently lost none of this precious quality.

We need this kind of leadership in research. The greatest rewards in research go to those who have the audacity to break into new fields. Duncan recognized, however, that careful, systematic work was also required and he said that some researches were like a brilliant, daring assault and that others were like siege operations.

It is easy, of course, to be audacious without intelligence, but not in business nor in scientific work. It is only in the field of politics where, as Machiavelli suggests, a great failure can be covered up by the brilliant pyrotechnic display of a new venture.

Some years ago another forceful character, Paul C. Freer, visited a famous research institute, and when asked what they were doing there, he replied "Practically nothing but worshipping at the tomb of the founder." This will not happen here, for the Mellon Institute does not even now completely attain the goal which was set. It is founded upon a dynamic idea, still feels the dynamic influence of its first director,

and the complete satisfaction of human needs and our thirst for new knowledge is beyond the capacity of our imagination.

Other elements of Duncan's leadership were his very human qualities, his warm sympathy, his capacity for emotion and his genuine interest in his associates. These qualities are certainly essential attributes of great leadership. Every soldier in Napoleon's army heard of how after midnight before the battle of Jena the little man took a lantern and helped a squad of gunners get a gun out of the mud and up the slope to its position. Duncan was interested in the personal success of every youngster who worked in these laboratories. He would often put his head through the door of one of the laboratories and say, "Boy, are all your problems solved?" We knew, after a little, that he meant more than our immediate research difficulties. And so I can easily imagine him repeating that question here to-night, notwithstanding this splendid building built by the Mellons, who believed in and shared his vision for better things for us all. Duncan might remind us gently that it is no time to rest on our oars, and he might even say to our director, "Boy, are all your problems solved?"

SCIENTIFIC EVENTS

SYMPOSIA AT THE DENVER MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SINCE the association covers practically the whole field of pure and applied science, it is in an especially favorable position for organizing symposia, particularly on subjects which extend across the borders of special sciences. Indeed, no other American society or association is so well qualified by breadth of interests, large membership, organization into sections and means for publication as is the association for promoting authoritative general synthesis of scientific knowledge. The Denver meeting from next June 21 to June 26 gives every promise of maintaining the high standards in symposia which have been set at earlier meetings.

It will be remembered that at the Atlantic City meeting last winter the Section on Medical Sciences (N) organized a symposium on cancer. The program consisted of 31 papers, which together cover in a systematic manner essentially all that is now known about this dreaded disease. These papers are being brought out in book form under the editorship of Dr. Henry B. Ward. Therefore, medical investigators and practitioners will soon have available at low cost a compact general survey of one of the most important fields of medicine.

At the approaching Denver meeting, the Section on Medical Sciences will present another symposium by distinguished investigators, this time on diseases caused by acid-fast bacteria. This symposium will be characterized by the same thorough planning as that on cancer, the papers falling under four general headings which together cover the whole field. The first will give a review of the bacterial, chemical and pathological characteristics of acid-fast bacteria. The second group will be devoted to tuberculosis and other animal diseases of acid-fast bacterial origin; the third, to leprosy; and the fourth, to human tuberculosis. At the Indianapolis meeting next winter, the same section will present a symposium on syphilis.

A symposium on a widely different subject is being organized for the Denver meeting under the joint auspices of the Ecological Society of America and the association, Dr. H. de Forest representing the former society and Dr. Henry B. Ward the latter. This symposium, which is on "The Scientific Aspects of the Control of Drifting Soils," is also one of a series under a continuing sponsorship. It also has to an exceptional degree both purely scientific and highly practical aspects, and it ranges broadly across geological, climatological, botanical and economic fields.

At another extreme is a symposium on "Cosmic Physics" by the Section on Physics (B) and the Pacific Coast Branch of the American Physical Society. Obviously, this subject has no present direct bearing on such practical questions as health or natural resources. Yet it stimulates the imagination and broadens the spirit. Its appeal is akin to that of philosophy and religion, and in the long course of time it may prove to be even more important to us as thinking beings than many of the so-called practical subjects.

Among other symposia which will be presented at the Denver meeting is one on "Rocky Mountain Spotted Fever," under the joint sponsorship of the Section on Zoological Sciences (F) and the American Society of Parasitologists; one on "Forests and Waters," under the sponsorship of American Foresters; one on "Airmass Analysis as Applied to Western United States," including the "Dust Bowl" problem, under the auspices of the American Meteorological Society, and one on "Radio Transmission and Solar Phenomena," under the joint auspices of the Section on Astronomy (D) and the Astronomical Society of the Pacific.

This brief sketch of the principal symposia that will be presented at Denver shows the richness and variety of the scientific programs of the approaching meeting of the association. To all these attractions, as well as those of the general lectures and the special programs of the fifteen sections and numerous related societies, are added the unsurpassed summer climate of Denver

and the magnificent neighboring mountains. It requires no prophet to foresee that the meeting will be very successful.

F. R. MOULTON,
Permanent Secretary

FUNDS FOR THE AMERICAN MUSEUM OF NATURAL HISTORY

A PLAN to raise $10,000,000 for the American Museum of Natural History has been announced by F. Trubee Davison, president of the museum. The museum has now an endowment fund of $16,176,640. Annual recurring expenses amount to $431,197, with a deficit of $55,000 for 1937. The new fund would be used to provide an income to cover these expenses and for a ten-year program of development in all departments.

Due to lack of funds the museum is handicapped by insufficient personnel and is unable to fill gaps in its collections, increase its public exhibits, broaden its teaching facilities, maintain its research and keep up to date with the publication of the results of its scientific work.

The expansion plans include an increase of forty per cent. in the staff of librarians, technicians and laboratory assistants, with salaries commensurate with those in similar institutions. The first application of the new funds, after covering the museum's deficit, would be to double expenditures for education. Objective demonstrations of such subjects as eugenics, environmental problems and conservation are planned. A large-scale development of the collection of American mammalogy may be undertaken and among other projects suggested are completion of the Hall of the Races of Man, a New Hall of Man dealing with embryology and the development of man's body and behavior, reconstruction and modernization of the American Indian Halls, the construction of an Australian Hall, a microvivarium, extension of the Reptile Hall and a North American Mammal Hall.

A series of expeditions suggested by the curators include: Field activities in Australia; ichthyological work in South America; expeditions to the California coast and to the Great Barrier Reef of Australia for the study of living invertebrates, and a field program to complete the museum's collection of fossils from every geologic age in the United States.

Mr. Davison is general chairman of the program, A. Perry Osborn, a member of the board of trustees, is executive chairman, Mrs. Winthrop W. Aldrich is vice-chairman, and E. Roland Harriman is treasurer. Other members of the committee for the campaign are George T. Bowdoin, W. Douglas Burden, Clarence L. Hay, Julius S. Morgan, Daniel E. Pomeroy, Leonard C. Sanford and Arthur S. Vernay.

DINNER OF THE SOCIETY OF THE FRIENDS OF SCRIPTA MATHEMATICA

ON the evening of May 9, at the Hotel Astor, New York City, the Society of the Friends of *Scripta Mathematica* held a dinner in honor of Professor Eric Temple Bell, for his contributions to public enlightenment regarding the significance of mathematics as an essential means to general culture. Dr. Bell gave the principal address. Other guests of honor were Professors Cassius Jackson Keyser and David Eugene Smith and Mr. M. Lincoln Schuster, publisher of *Scripta Mathematica*. The speakers included Professors William P. Montague, Edward Kasner and Joseph Shipley. Professor J. Ginsburg, editor of the journal, acted as chairman.

The dinner was attended by more than 150 friends of the journal and of the society. The proceeds of the dinner will be used for the publication fund of the journal, said to be the only mathematical magazine in the world edited by specialists for laymen. In addition to the *Scripta Mathematica*, a quarterly, the first issue of which appeared in 1933, the society publishes a mathematical library of volumes for the general public, the latest of which is "Every Man a Millionaire," by a mathematician with the pseudonym David Dunham. The second series of the "Portraits of Eminent Mathematicians," by Professor Smith, the first of which appeared last year, is in preparation. These portraits, printed with explanatory text by Dr. Smith, are taken from the collection, part of which was presented by Professor Smith to Columbia University on his retirement from active service.

Associate editors of *Scripta Mathematica* include: Dr. Joseph J. Schwartz, executive director of the Brooklyn Jewish Federation, Dr. David E. Smith, Dr. Cassius J. Keyser, Professor Louis Charles Karpinski, Sir Thomas Little Heath, Dr. Adolf Fraenkel, now at the Hebrew University in Jerusalem, Professor Lao Genevra Simons, Vino Loria and Vera Sanford.

In setting forth the purposes of the society, Dr. Ginsburg pointed out that although there were many mathematical journals, they were usually closed to the lay reader and circulated only among mathematicians, and that *Scripta Mathematica*, which includes departments devoted to book reviews, biographies, "recreational mathematics" or unique mathematical puzzles, as well as more formal papers on various aspects of the history and philosophy of mathematics, provides a publication for the man who is not a specialist in the field.

In addition to the issues of the journal, the three books in the mathematics library and the first series of "Portraits of Eminent Mathematicians" were on display. Further publications in preparation were announced, including "Mathematical Ideas in Design," by

Rutherford Boyd, and "Magic Squares and Cubes," by Royal V. Heath.

THE AMERICAN ACADEMY OF ARTS AND SCIENCES

At the annual meeting of the American Academy of Arts and Sciences, held on May 12 at its house, 28 Newbury Street, Boston, Mass., it was voted to award the Rumford Medal to William Weber Coblentz, physicist of the Bureau of Standards, Washington, D. C., in recognition of his investigations in heat and light, including the physical study of the firefly, photoelectric properties of materials, the radiation of stars and pioneer work on the temperatures of the planets.

The Rumford Fund was established by a gift to the academy in 1796 from Sir Benjamin Thompson, Count Rumford, from the income of which medals may be awarded whenever the academy sees fit "to the author of any important discovery or useful improvement in light or heat, which shall have been made in any part of America."

At this meeting one foreign honorary member was elected—M. Henri Piéron, psychologist, University of Paris—and sixteen fellows, of whom the following represent the scientific sections of the academy:

Class I—Mathematical and Physical Sciences

Kenneth Tompkins Bainbridge, assistant professor of physics, Harvard University.

John Tileston Edsall, assistant professor of biological chemistry, Harvard University.

Gustavus John Esselen, consulting chemical engineer, Boston.

Joseph Henry Keenan, associate professor of mechanical engineering, Massachusetts Institute of Technology.

Ernest Orlando Lawrence, professor of physics, University of California.

George Walter Stewart, professor of physics, University of Iowa.

Jabez Curry Street, assistant professor of physics, Harvard University.

Harald Malcolm Westergaard, professor of civil engineering, Harvard University.

Class II—Natural and Physiological Sciences

Walter Walker Palmer, director of medical service, Presbyterian Hospital, New York City.

Alfred Sherwood Romer, professor of zoology, Harvard University.

The following officers were elected for the coming year:

President: Dugald Caleb Jackson.
Vice-president, for Class I: James Flack Norris.
Vice-president, for Class II: Walter Bradford Cannon.
Vice-president, for Class III: George Grafton Wilson.
Vice-president, for Class IV: Arthur Stanley Pease.
Corresponding Secretary: Leigh Hoadley.
Recording Secretary: Tenney Lombard Davis.
Treasurer: Ingersoll Bowditch.
Librarian: Hervey Woodburn Shimer.
Editor: Charles Henry Blake.

Professor Percy W. Bridgman spoke on "Physical Phenomena at High Pressure."

THE DIRECTORSHIP OF THE HOSPITAL OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

Dr. Thomas Milton Rivers, at present a member of the Rockefeller Institute, has been selected as director of the Department of the Hospital of the Institute to succeed Dr. Rufus Cole, who has reached the age of retirement and is withdrawing from the directorship of the hospital on June 30.

Dr. Cole has been director since its founding in 1910. When the institute was started, provision was made only for laboratories; but after a few years had elapsed the need became apparent for a hospital in which disease could be studied as it actually occurs in man. An additional gift to the funds of the institute by John D. Rockefeller made the hospital possible; and Dr. Cole, an associate in the department of medicine at the Johns Hopkins Medical School, was chosen to be placed at its head.

At that time hospitals having for their major function the investigation of disease were practically unknown. Dr. Cole started by selecting a small group of men with special interests in the basic sciences; and in the construction of the hospital building he arranged to have wards and laboratories in close proximity, so as to make readily available for the analysis of the phenomena associated with disease the techniques that had been provided through advancement in the sciences of physics, chemistry and biology. He has directed his energies and those of his staff toward the study of the common diseases which affect a large number of persons. Acute respiratory diseases, rheumatic fever, diseases of the heart, Bright's disease and the exanthematous diseases of childhood are among those which have been subjected to almost uninterrupted investigation at the hospital. No less than thirty men who have worked with Dr. Cole in the Hospital of the Rockefeller Institute now hold professorships in the medical schools of the United States and abroad.

Dr. Rivers was associate in the department of bacteriology of the Johns Hopkins Medical School, remaining there until his appointment as associate in the hospital of the Rockefeller Institute in New York in 1922. In 1927 he was appointed to membership in the institute. While at the Johns Hopkins University, he conducted studies on influenza bacilli, which resulted in the discovery of a new bacterium, *Hemophilus parainfluenzae.* Later at the Rockefeller Institute he undertook investigations of the filterable

viruses. These led to the discovery of Virus III and the development of methods of growing viruses in tissue cultures. A vaccine prepared from cultured virus is now available for the prevention of smallpox in human beings. He has worked on psittacosis and has developed a safe method of diagnosing the disease by the use of white mice instead of birds. His most recent work has dealt with a new disease, lymphocytic choriomeningitis, that attacks the central nervous system of man.

SCIENTIFIC NOTES AND NEWS

FELLOWS of the Royal Society, London, were elected on May 6 as follows: John Desmond Bernal, lecturer in crystallography, University of Cambridge; Albert Charles Chibnall, assistant professor of biochemistry, Imperial College of Science and Technology; George Roger Clemo, professor of chemistry, Armstrong College, University of Durham; Alan Nigel Drury, M.D., lecturer in pathology, University of Cambridge; Harold Munro Fox, professor of zoology, University of Birmingham; William Edward Garner, professor of physical chemistry, University of Bristol; Sydney Goldstein, Ph.D., lecturer in mathematics, University of Cambridge; Percival Hartley, D.Sc., director of biological standards, National Institute for Medical Research; Herbert Leader Hawkins, professor of geology, University of Reading; the Rev. John Ernest Holloway, lecturer in botany, University of Otago; William Hume-Rothery, D.Sc., Warren research fellow of the Royal Society; Thomas Godfrey Mason, Sc.D., Cotton Research Station, Trinidad; James Reid Moir, archeologist; Marcus Laurence Elwin Oliphant, Ph.D., assistant director of research, Cavendish Laboratory, University of Cambridge; Carl Frederick Abel Pantin, Sc.D., lecturer in zoology, University of Cambridge; David Randall Pye, Sc.D., deputy director of scientific research, Air Ministry, and Edmund Clifton Stoner, Ph.D., reader in physics, University of Leeds.

PROFESSOR W. L. BRAGG, Langworthy professor of physics in the University of Manchester, has been appointed director of the British National Physical Laboratory. He will assume duty in the autumn.

DR. T. MADSEN, chief of the State Serum Institute in Copenhagen, has for the seventh time been elected president of the Health Committee of the League of Nations. Dr. Madsen recently gave the Abraham Flexner lectures at Vanderbilt University, where he was in residence during March and April.

THE council of the British Royal Institute of Public Health has awarded the Harben Gold Medal to Sir Frederick Gowland Hopkins, professor of biochemistry at the University of Cambridge. The medal is awarded triennially under a trust created by the late Sir Henry Harben "to the person, irrespective of nationality, who, in the opinion of the council, has rendered the most eminent services to public health."

THE Patrons' Medal of the Royal Geographic Society, London, has been awarded to Lincoln Ellsworth for his Antarctic flight of 1936.

THE Société Nationale d'Acclimatation de France has awarded its 1936 silver medal to Dr. George S. Myers, of Stanford University, in recognition of his researches on fishes, particularly the smaller tropical fresh-water species. The presentation was made on March 15 by M. Albert Lebrun, president of the French Republic.

DR. JAS. LEWIS HOWE, dean of the School of Applied Science and head of the department of chemistry of Washington and Lee University, has been awarded the Herty Medal of the Southern Division of the American Chemical Society "for outstanding work on chemistry in the south."

THE Army Ordnance Association has conferred its Medal of Merit upon Major General J. G. Harbord, chairman of the Board of the Radio Corporation of America. The ceremony of presentation took place on May 12 at the Mayflower Hotel, Washington, D. C.

DR. WILLIAM H. DOHERTY, of the Bell Telephone Laboratories, has been awarded by the Institute of Radio Engineers the Morris Liebman Memorial Prize for 1937, in recognition of his work in the field of radio-frequency power amplifiers. The presentation was made at the annual dinner of the institute in New York on May 12.

THE doctorate of science has been conferred by Clemson College on Dr. George W. Keitt, head of the department of plant pathology of the University of Wisconsin, in recognition of his contributions in the field of plant diseases. The degree was conferred on the occasion of the dedication of the new agricultural building on May 12.

THE degree of doctor of science will be conferred at the summer convocation of the University of Durham on Sir Henry Dale, director of the National Institute for Medical Research.

DR. DAVID RIESMAN, emeritus professor of clinical medicine at the School of Medicine of the University of Pennsylvania, professor of clinical medicine in the Graduate School of Medicine and professor of the history of medicine in the Graduate School of Arts

and Sciences, was the guest of honor at a testimonial dinner on his seventieth birthday, March 25. Dr. Russell S. Boles was toastmaster, and the speakers included: Dr. Josiah Penniman, provost of the University of Pennsylvania; Dr. William Gerry Morgan, Washington, D. C.; Dr. Henry A. Christian, Boston; Dr. Lewis A. Conner, New York; Dr. Alfred Stengel and Dr. Wilmer Krusen. A volume of his selected writings was presented to Dr. Riesman, in which is an engraved plate bearing the names of his former and present assistants.

DEAN EMERITUS FREDERICK J. WULLING, of the College of Pharmacy of the University of Minnesota, was the guest of honor at the fifty-third annual banquet of the Minnesota State Pharmaceutical Association in St. Paul. Dean Wulling, who retired in the spring of 1936 after a career that began at the university in 1892, was presented with a memorial plaque by members of the association "in honor of his distinguished service."

DR. ELMER K. BOLTON, chemical director of the E. I. du Pont de Nemours and Company, has been elected a director of the American Chemical Society. Dr. Bolton succeeds Dr. Frank C. Whitmore, of Pennsylvania State College, who will become president of the society on January 1.

PROFESSOR WILLIAM CARUTH MACTAVISH, administrative chairman of the department of chemistry of Washington Square College, New York University, has been elected chairman of the New York Section of the American Chemical Society.

DR. WESLEY R. COE, for twenty-eight years professor of biology at Yale University, will retire after a year's leave of absence beginning at the close of the present academic year.

DR. LINUS PAULING, professor of chemistry at the California Institute of Technology, has been appointed George Fisher Baker lecturer in chemistry at Cornell University for the first term of the year 1937–38.

DR. HARALD M. WESTERGAARD, Gordon McKay professor of civil engineering at Harvard University, has been appointed dean of the Graduate School of Engineering.

DR. ERWIN E. NELSON, professor of pharmacology of the Medical School of the University of Michigan, has been made head of the department of pharmacology at the School of Medicine of Tulane University of Louisiana, New Orleans, succeeding Dr. John T. Halsey, who is retiring at the close of the present session.

DR. GEORGE E. WAKERLIN, professor of pharmacology and physiology at the School of Medicine of the University of Louisville, has been appointed professor and head of the department of physiology at the College of Medicine of the University of Illinois. Dr. Wakerlin will succeed Dr. Maurice B. Visscher, who was recently appointed professor and head of the department of physiological chemistry at the School of Medicine of the University of Minnesota.

MISS MABEL HEREN, in honor of thirty years' service as a member of the department of mathematics of Knox College, has been appointed to the Henry M. Hitchcock chair of mathematics.

DR. JULIA M. SHIPMAN, assistant professor in the department of geography at Mount Holyoke College, has leave of absence for the academic year 1937–38 to teach at Ginling College, Nanking, China.

DR. GEORGE A. HARROP, of the Johns Hopkins Hospital, has become director of research on the staff of E. R. Squibb and Sons, of New York. A new research laboratory is in process of construction at New Brunswick, N. J. Investigation along scientific lines will be carried on without necessary regard to its immediate practical outcome. It is also planned, in the near future, to undertake active clinical investigation with which to supplement and give orientation to the laboratory studies.

CLARENCE L. FORSLING, director of the Appalachian Forest Experiment Station at Asheville, N. C., has been appointed assistant chief forester in charge of the research activities of the U. S. Forest Service. He will supervise the work of the Divisions of Silvics, Forest Influences, Range Research, Forest Products and Forest Economics, which are carrying on specialized investigations in the protection and management of forest and range lands, the utilization of wood and other phases of forestry.

ERNEST SEGESSEMANN, a member of the laboratory staff of the National Oil Products Company, Harrison, N. J., has been made chief chemist of the company's new plant at Cedartown, Ga.

DR. WILLIAM CROCKER, director of the Boyce Thompson Institute for Plant Research, has been elected president of the Board of Education of Yonkers, N. Y.

DR. ERNEST O. LAWRENCE, professor of physics and director of the radiation laboratory at the University of California, spoke on "Atoms, New and Old" at the St. Louis University Medical School on May 12.

DR. P. W. ZIMMERMAN, of the Boyce Thompson Institute, Yonkers, N. Y., spoke before the Sigma Xi Club of the University of Florida on April 22. His subject was "Plant Responses to Hormone-like Substances."

DR. FREDERICK C. LEONARD, chairman of the department of astronomy of the University of California at Los Angeles and president of the Society for Research on Meteorites, gave on April 7 an illustrated lecture entitled "Visitors from Cosmic Space," before the University Chapter of the Society of the Sigma Xi.

THE Linacre Lecture of the University of Cambridge was delivered by Dr. A. V. Hill, Foulerton research professor of the Royal Society on May 10. His subject was "The Heat-Production of Muscle and Nerve: A Critical Survey."

IN the account of the presentation of the medals of the National Academy of Sciences printed in the issue of SCIENCE for May 7, the address on presenting the Henry Draper Medal to Dr. C. E. Kenneth Mees is in error attributed to Dr. Frank Schlesinger. The address was read by Dr. Schlesinger, but should have been signed by Dr. V. M. Slipher, director of the Lowell Observatory, who is chairman of the Draper committee.

THE annual meeting of the Royal Institution of Great Britain was held on May 1. The London *Times* states that it was reported at the meeting that the total membership of the institution, which has been increasing for several years, is now 1,055. The library reconstruction was completed in October last, at a cost, as the accounts showed, of upwards of £15,000. The amount the institution has received by the bequest of the late Mr. Harry Brown is now announced as £29,000. The account of the Davy Faraday Research Laboratory, which is attached to the institution, showed a deficit for the year of nearly £2,000; but the chairman was able to announce a promise by Sir Robert Mond, honorary secretary of the laboratory, to meet this deficit. The following were elected for the year 1937–38: *President,* Lord Eustace Percy; *Treasurer,* Sir Robert Robertson; *Secretary,* Major Charles E. S. Phillips.

THE College of Physicians of Philadelphia held on May 14 and 15 a celebration of the hundred and fiftieth anniversary of its founding in 1787, the year of the Constitutional Convention. The speakers were Roland S. Morris, president of the American Philosophical Society; Dr. David Riesman, professor of the history of medicine in the Graduate School of Arts and Sciences of the University of Pennsylvania; Sir Henry Dale, director of the British National Institute for Medical Research, and Dr. Hans Zinsser, professor of bacteriology in the Harvard Medical School.

AN international colloquium on the physiology of the sex hormones, under the presidency of Professor Pol Bouin, of the faculty of medicine of the University of Strasbourg, will be held in Paris this June under the auspices of the Singer-Dolignac Foundation. Twenty investigators particularly qualified by their work in the subject have been invited to attend, all expenses being defrayed by the foundation. Those in the United States who have received invitations are Dr. Frederick L. Hisaw, professor of zoology at Harvard University; Dr. Edgar Allen, professor of anatomy at Yale University; Dr. Philip Smith and Dr. Aura E. Severinghaus, of the College of Physicians and Surgeons, Columbia University, and Dr. Carl G. Hartman, of the department of embryology of the Carnegie Institution of Washington at Baltimore.

CONSTRUCTION work on the extension of the School of Medicine of Columbia University was begun on April 1. The plans, which will necessitate an expenditure of $600,000, provide for the addition of ten stories to the present six-story extension of the west wing of the building at the Columbia Medical Center. The additional space will be used mainly to house the research laboratories of the five graduate departments—anatomy, pathology, biochemistry, physiology and bacteriology—which now are confined to the lower floors of the wing.

DISCUSSION

THE NEEDS OF THE MIMICRY THEORY

IT seems inevitable that any adverse criticism of the theory of mimicry should bring forth more examples and arguments in its support, of the kinds which have long been on record. Professor Carpenter[1] has therefore done the expected in coming to the defense of the theory after the critical discussions in the author's recent book[2] on evolution.

No attempt will be made to refute his arguments or to show *individually* why the cited examples do not prove mimicry to be the thing it has been claimed to be. The examples could not be proved meaningless without a very much closer study than is possible from the few facts known and recorded. It is likewise true, though not so pleasant a thing to say, that of the examples, new and old, few or none could be successfully advanced to prove the advantages and the origin of mimicry without a much closer study of them than has ever been made. If the same rigid requirements were insisted upon for proof as are currently demanded for disproof, the theory would hardly have gained prominence. We are called upon to accept mimicry until it has been clearly disproved, whereas it would be more logical to reject it until clearly estab-

[1] SCIENCE, 85: 356–359, 1937.

[2] A. F. Shull, "Evolution." New York: McGraw-Hill Book Co. 1936.

lished. It is the author's view that the latter has not happened, though he is quite willing that it should.

Unless proponents and opponents agree on standards of evidence it is not likely that either will satisfy the other. There is no common ground for discussion until the fundamental question, what is involved in judging mimicry, is settled. Examples mean nothing unless it is understood what they must show. A critical biologist will hold that these judgments lie mainly in two fields, genetics and animal behavior—the former relating to the origin of mimicry, the latter to its current value to the mimics.

Into the first of these fields Professor Carpenter would prevent us from entering, on the ground that the problems of mimicry are questions, not of origin, but of survival. If students of mimicry are all prepared to subscribe to that view, a long step toward simplification will have been taken. However, there were certainly some supporters of mimicry in the past who held that mimics came to be what they are because of the advantage it brought to them. The mimicking types were supposed, by these naturalists, to arise out of non-mimicking stocks, gradually through the accumulation of modifications leading to greater and greater similarity to some protected form. This involves survival, but it also includes successive mutation.

It makes a great deal of difference whether similarity to a protected and unrelated animal came about by a single change or by many. If students of mimicry are all agreed that mimicking color, form or habit arose by one mutation in a type possessing no approach to the protecting quality of the model, the argument is simplified and a good deal of history of the evolution idea is now ancient history. If there still be some who maintain that mimicry arose gradually, a distinction will have to be made, and two kinds of arguments advanced to oppose the two kinds of mimicry. If Professor Carpenter is correct in saying that only survival, not origin, is involved in mimicry, which implies the one-mutation origin of the imitations, then the advantage of the new character had nothing to do with its nature. A mutation occurred, often involving (we have been told) many details, and it happened to help its possessor. Since the details have been important in creating the illusion in the minds of predators, the single mutation was a rather remarkable occurrence. Yet its nature was wholly accidental. The marvels of mimicry thus become the wonders of the physiology of development. The latter field is one which the geneticists hope to make their own, but it is important that students of mimicry take the lead in this particular phase of the problem.

Addressing now those who perhaps still believe that mimicry arose gradually, that perfection of the mimic involved many steps, one should point out that survival must be aided by successive mutations which must occur in an order that will build up greater and greater resemblance. If this concept of mimicry be adopted, it becomes of the utmost importance to the theory to know by how many genes a mimic differs from its non-mimetic relatives, how many of these genes have anything to do with appearance, and what phenotypes would result from various combinations of smaller numbers of the differentiating genes. Only with such knowledge can we have any reason to adopt any theory of either origin or survival.

Whichever view of the simplicity or complexity of mimicry be adopted, knowledge of origin belongs in fields which the geneticists claim. If the problems of mimicry are not geneticists' problems, whose are they? They *should* be the problems of all who believe that mimicry as an advantage exists. Students of mimicry are appealed to to furnish the necessary analyses. They know the phenomena in nature; they know, or can learn better than any one else, how to rear the mimics and their relatives; and they have a better opportunity to discover which ones, despite their specific distinctions, still can be crossed. If they can be convinced of the need of these genetic analyses, the outlook for progress is by no means dull.

Let us turn now to animal behavior, the field in which Professor Carpenter holds the entire argument to lie. He implies that it is somehow reprehensible to comment "on the danger of drawing conclusions from experiments on animal behavior," and then cite experiments on the color vision of fowls. Professor Carpenter has missed most of the point to this caution. It is of the greatest importance that there be experiments on behavior. But they must be adequate ones. Without them we go on deciding on very meager bases what an animal "likes" by something that it does, what it "perceives" by some small item of its behavior, what is "suggested" to it by an appearance that suggests something to us, what reaction it gives to a "black and stinking" beetle which impresses us as deserving those adjectives, what it "wants," what it "endeavors" to do. It is very difficult to make the study of animal behavior objective. That is why this branch of biology is one of the least developed of the biological disciplines. Why should we pretend it is easy and continue to form judgments from a few observations? They are almost certain to be wrong in part. We do not even know the entire basis of human behavior. There is not one among us who can say exactly what all elements enter into a judgment. Try as we may to be objective, we all occasionally fail; and when we recognize our failing, we often can not tell what emotion or feeling it was that supplanted reason or a fact. How can we judge other animals' behavior when we do not know

the basis of our own? How likely are we to judge it correctly if, under these circumstances, we insist on judging?

As for experiments on behavior relating particularly to mimicry and warning color, there appears to be only one series that was at all adequate. They were the tests made by Reighard[3] on coral reef and other small fishes and their neighboring predators. Professor Carpenter does not mention these experiments. They turned out to be against the warning color theory, and upset a number of preconceived ideas of how these fishes behave and why they do so. Nor does he mention the stomach contents of birds (McAtee[4]), which are one of the consequences of animal behavior. These go to show that many animals held to be protected, whether through imitation or otherwise, are not very immune to capture after all. It will require a good many casual observations and brief tests to overthrow a thorough, analytical and objective group of experiments and a mass of concrete facts on feeding habits. That is why such tests should cease to be casual and brief. Nothing less complete than the Reighard experiments will suffice, and students of mimicry are urged to make their tests of behavior as full and inquisitorial. The only alternative is to refrain from drawing conclusions.

"Few critics seem to be aware of the great extent of the phenomenon." Were its extent twice as great, its problems would not be solved. What mimicry needs is not a broader foundation, but a deeper one. Those who have made known the large number of instances of it are in the best position to furnish this depth. It is to be hoped they will direct their chief energies to that end.

A. FRANKLIN SHULL

DEPARTMENT OF ZOOLOGY
UNIVERSITY OF MICHIGAN

HETEROTHALLISM IN VENTURIA INAEQUALIS

IN October, 1935, conidia from cultures obtained by isolating each of the eight spores of an ascus of *Venturia inaequalis* were used to inoculate the leaves of potted Fameuse apple trees that had been held in cold storage and recently forced out in the greenhouse. Conidia from each isolate were used alone and mixed in every possible two-isolate combination. Infection resulted from every inoculation, whereas uninoculated trees remained free from it. Leaves from the experimental trees were overwintered and examined microscopically for perithecia of *V. inaequalis*. None of the uninoculated leaves or those inoculated with conidia from any single isolate of the fungus bore perithecia. The results from the two-isolate inoculations showed that the eight isolates fell into two groups of four each. All the 16 possible combinations between these two groups yielded perithecia that bore ascospores. None of the 8 combinations in which conidia from an isolate were mixed with those from another within the same group yielded perithecia that bore ascospores, except in three cases, in each of which the fertile ascocarps were borne in a strictly localized area. These seemingly aberrant cases are thought to have been due to contamination. Cleared-leaf studies showed that perithecial initials were formed abundantly when single isolates or non-fertile mixtures were used, but they usually attained less than one half the diameter of the normal, mature perithecium. The experiment is being repeated with modifications and supplemented by pure-culture studies. The available evidence seems to justify the conclusion that *V. inaequalis* is heterothallic, each isolate being hermaphroditic and self-sterile.

G. W. KEITT
D. H. PALMITER

UNIVERSITY OF WISCONSIN

AN ANALOGUE OF PLATEAU'S SPHERULE

IF a falling stream of water is examined with a stroboscope at the point where it breaks up into drops, a tiny droplet may be seen formed apparently from the "tails" between successive drops. This droplet is generally known as Plateau's spherule, after the inventor of the stroboscope.

While emptying two flasks with special constricted necks, I was very much interested to observe a similar phenomenon which may be seen quite easily without the aid of stroboscopic vision. The necks of the flasks were so narrow (4.0 mm i.d.) that air entered in discrete bubbles. Between successive bubbles, tiny bubblets of air were formed which could be observed rising slowly through the solution.

The phenomenon was first observed while emptying a saturated solution of barium nitrate in 33 per cent. nitric acid from the flasks. When the flasks were filled with pure water for calibration, no spherules of air were seen on emptying. Apparently, the formation of the tiny bubbles from the thread of air, left as a large bubble breaks off, depends upon a suitable relationship between surface tension, mobility and density of the liquid, for a given type of neck. With concentrated 70 per cent. nitric acid the effect is not as good as with 40 per cent. acid although occasional bubblets may be seen. Fifteen per cent. alcohol is as good as the 40 per cent. nitric acid, and the effect may also be seen quite well with 95 per cent. alcohol. With ethyl ether the formation of the spehrules was also observed. In this liquid there were frequently three

[3] J. E. Reighard, Carnegie Inst. Wash. Pub. 103: 257–325, 1908.

[4] W. L. McAtee, Smiths. Inst. Misc. Coll. 85(7), 1932. Also *Quart. Rev. Biol.*, 8: 209–213, 1933.

or four of the spherules between the successive bubbles of entering air.

CHARLES H. GREENE

RADCLIFFE COLLEGE

SEASIDE SHRUBS: WIND FORMS VS. SPRAY FORMS

ON the basis of recent observations on the lower Cape Fear Peninsula, we have found that the so-called "wind-form" shrubs owe their form not to the wind *per se* but to the sea spray carried by high winds. Marked injury of all the young shoots exposed on the southeast side of the shrub masses (wax myrtle, yaupon and live oak) was observed following a high southeast wind which persisted for a period of nineteen hours and reached a maximum well above thirty miles per hour. We found this injury only on shrubs located near the strand; those equally exposed to the same wind velocity but at a greater distance from the ocean showed no injury whatever. And the degree of form modification was strictly correlated with the amount of injury found. Relatively low temperatures and cloudy weather prevailed during the time of this wind. Abundant soil moisture was also present, so that the drying effect of the April wind may be ruled out as an important factor.

Injured shoots and slightly protected uninjured ones were washed in distilled water and the water tested for chlorides, using silver nitrate solution. A marked contrast was found in the concentration of chlorides on the surface of exposed shoots *vs.* nearby ones slightly protected.

Immature shoots of a number of woody plants were hand sprayed with sea water and a pattern of injury obtained similar to the injury recently observed on the seaside shrubs.

Plant ecologists have generally attributed the strongly modified form of the seaside woody plants to wind alone. Our observations definitely indicate that the principal factor in producing these "wind forms" is the killing action of sea water carried as fine spray. The young, tender, exposed shoots are so severely injured by the spray that only the protected laterals and leeward terminals develop, resulting in the characteristic, compact, repressed, sloping form.

These peculiarly shaped seaside shrub masses should be called "spray forms" rather than "wind forms."

B. W. WELLS
I. V. SHUNK

NORTH CAROLINA STATE COLLEGE

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MINUTES OF THE EXECUTIVE COMMITTEE

THE spring meeting of the executive committee of the association was held in the Hotel Commodore in New York City on April 17 and 18. All members of the executive committee were present with the exception of the Pacific Coast representative, who was duly excused. The minutes of the Atlantic City meetings as approved by mail were presented for record.

In response to an inquiry from affiliated state academies it was voted to reaffirm previous action regarding academy research grants to the effect that these are primarily for specific research projects according to the plan approved and transmitted to all academies and not for meeting the costs of printing the publications of any academy.

Itemized statements regarding the finances of the offices of the permanent secretary and the treasurer, in regard to the present status of membership and of means to be taken to extend the membership of the association were laid before the committee and after general discussion approved.

In order to clear up confusion and possible misunderstanding it was voted that section secretaries who prepare the programs and attend the Denver meeting to take charge of the work of the sections are to be reimbursed for travel and expense in accordance with the by-laws.

Correspondence from Mr. Charles S. Baker, legal counsel, was presented. The permanent secretary reported (1) the receipt of an official ruling from the Massachusetts Department of Public Welfare to the effect that under the law the American Association for the Advancement of Science was not required to file returns; and (2) that affidavits by our officers and power of attorney as requested by the legal counsel had been prepared and sent Mr. Baker for use in discussing the taxation of the American Association for the Advancement of Science before the Bureau of Internal Revenue.

Various requests were presented that the travel expenses of certain speakers at the Denver meeting be paid from association funds. The committee expressed its regret that no funds were available to meet these requests.

An extended report was made by the permanent secretary on Occasional Publication No. 4, which is to contain the papers read at the cancer symposium organized by the Section on Medical Sciences for the Atlantic City meeting.

On recommendations of the respective sections fel-

lows were elected as follows: Section on Mathematics, 1; Section on Psychology, 8; Section on Social and Economic Sciences, 5; Section on Medical Sciences, 1.

Dr. E. G. Conklin was elected as representative of the association on the board of trustees of Science Service in place of Dr. B. E. Livingston, who had resigned.

The Psychometric Society was accepted as an affiliated society. This organization has a total membership of 159. Of this number 74 are members of the association, 58 of these being fellows. The society is entitled to one representative in the council.

The American Philosophical Association expressed its acceptance of the invitation to change its status from that of an associated society to an affiliated society.

It was voted to hold the 1940–41 winter meeting in Philadelphia and to authorize publication of this decision.

It was voted to hold the 1939 summer meeting in Milwaukee and to authorize publication of this decision.

It was voted to appropriate to *Biological Abstracts* $150 from the treasurer's funds for general purposes, the officers of the journal to be notified that this is the final grant from the association for this purpose.

The chairman appointed the president and the permanent secretary representatives of the association for the meeting of the British Association for the Advancement of Science, to be held at Nottingham, from September 1 to 8.

Dr. Atherton Seidell was selected as delegate from the association to the Dix-septième Congrès de Chimie industrielle, Paris, from September 26 to October 2.

The committee adjourned at 3:45 P.M., to meet in Denver in June. (The usual program calls for the executive committee to meet on Sunday afternoon and evening prior to the opening of the meeting on Monday, June 21.)

HENRY B. WARD

REPORTS

ACTIVITIES OF MELLON INSTITUTE DURING THE PAST YEAR

THE major event during the past fiscal year of Mellon Institute was the transfer of almost all the organization's activities to its new building, completed after a construction period of six years, and dedicated May 5 to 9 to science and humanity in honor of the institution's founders, Andrew W. Mellon and Richard B. Mellon.

The fiscal year just closed marks the twenty-sixth anniversary of the establishment of the Institute's fellowship system. The expansion of activities made possible by the new building is reflected by the increase in the total sum contributed to the institution by industrial fellowship donors. This sum amounted to $816,315 for the fiscal year, March 1, 1936, to March 1, 1937, bringing the total for the past twenty-six years to $11,478,406.

Sixty-nine industrial fellowships—30 multiple and 39 individual fellowships—were in operation throughout the fiscal year, requiring the services of 125 fellows and 52 fellowship assistants. In operation at the close of the year were 64 industrial fellowships—27 multiple and 37 individual fellowships—on which 114 fellows and 41 assistants held positions. Thirty-three fellowships have been in continuous operation for five years or more, and of this number 15 have been active for 10 years, 11 have concluded 15 years or more of research, and 7 fellowships are 20 years of age or older.

During the calendar year 1936, 1 book, 13 bulletins, 17 research papers and 31 other articles were contributed to scientific and technical literature by Institute members. Fifty United States patents and 14 foreign patents on fellowship inventions came to issue. Since 1911, the total number of publications includes 19 books, 143 bulletins, 744 papers and 1,117 miscellaneous articles. During the same period, 668 United States patents were granted. Bibliographic bulletin 4, to be issued later this year, will cover the Institute's patents and contributions to literature from 1911 to 1936.

Eleven fellowships began operation during 1936–37 on the following subjects: household utilities, plate glass, mineral products, pasteurization, drying, air pollution survey, chain, raolin, surgical supplies, chromium and cork. Investigational programs were concluded by five fellowships: smoke abatement, cosmetics, closure, can and shoes. Three recently accepted fellowships will start work this spring.

The activities of the Institute are described in the annual report of the director, E. R. Weidlein. Releasable facts relating to the institution's investigational progress are here summarized:

Fundamental studies of anthracite fuel beds and heat-transfer methods were made by the anthracite fellowship under H. J. Rose. Through the researches of E. P. Barrett, a process has been commercialized for the removal of taste- and odor-producing substances from protective coating materials for food containers. R. R. Fulton's fellowship has developed a hydraulic pressure transmitting fluid for the brake systems of automobiles and airplanes. A comprehensive study recently completed by the fellowship headed by C. W. Sweitzer on the dispersion behavior of carbon blacks in oil- and varnish-type vehicles will assist

greatly in the more satisfactory and wide-spread use of these pigments.

The cottonseed product fellowship in charge of A. W. Harvey has made an investigation of the causes and control of mold development in certain types of cakes. A broad study of plastic fats has established the fact that the shortening properties of these materials are functions of physical and chemical characteristics rather than of biological origin. The basic program of the department-store commodity standards fellowship, under the direction of Jules Labarthe, Jr., emphasized the pre-evaluation of merchandise, the selection of store supplies, the giving of miscellaneous technical aid to the store and its customers and the study of complex complaint cases.

A new strained beef and liver soup, which appeared on the market in 1936, was developed by the multiple fellowship on food varieties headed by E. R. Harding. Material for laboratory table tops, sinks and similar equipment, previously developed by S. M. Phelps of the Institute, has been improved and carried into commercial production by the laboratory fellowship held by E. E. Marbaker. This material has been used in the new Institute building. Under the leadership of H. F. Robertson, studies have been conducted on the synthesis of a number of organic compounds and the development of commercial applications that may follow when such preparations become available in larger quantities.

During the year the petroleum fellowship completed a quarter-century of continuous operation. The work of the fellowship has covered a wide range of problems, including almost all types of petroleum products and uses. W. A. Gruse has been the senior fellow since 1923. A multiple fellowship, held by F. W. Adams, was established during the year to undertake basic researches in plate glass, paints and certain heavy chemicals. Striking correlations have been established between adherence of dry-process porcelain enamels on cast iron and composition and fabrication procedure by the porcelain enamels fellowship under D. G. Bennett. Studies were made by J. H. Young, senior fellow of the multiple fellowship on protected metals, to determine the type of cellular floor unit that would be best suited to residence construction. Investigations of the protective coatings fellowship in charge of G. H. Young have been aimed at the elucidation of fundamental film structure and basic principles determining adhesion, flexibility and continuity of commercial synthetic resin coatings.

Practical production of the new alloy developed last year as an improved razor blade material has been perfected, but the steel has not yet been produced in quantity. E. J. Casselman holds the fellowship concerned. An important addition to sanitational progress in machine dishwashing has been made by the development of sodium hexametaphosphate for this purpose by a fellowship under B. H. Gilmore. Artificial methods to accelerate the weathering of stone up to a hundred-fold have been evolved by the fellowship under R. C. Briant. The procedures were necessary in fundamental studies of commercial marbles and their uses. The practical superiority of plasticized sulfur as a jointing material in brick highway construction has been demonstrated by severe road tests under adverse weather conditions conducted by W. W. Duecker's fellowship.

Research designed to combat silicosis and similar diseases was inaugurated during the year by a fellowship at Mellon Institute under the sponsorship of Air Hygiene Foundation of America, Inc. H. B. Meller is managing director of the foundation, which is now supported by approximately 150 firms in most of the "heavy" manufacturing and mining industries. It is immediately concerned with diseases arising from industrial air contaminants—dusts, fumes, gases and vapors. The purposes of the organization, as set forth in its code of regulations, follow: It shall conduct and stimulate research on problems in the field of air hygiene and gather and disseminate factual information relating thereto. It will cooperate with and assist other agencies active in this domain and will collaborate in the coordination of such investigations.

The program for 1936 involved the collection and evaluation of information available on the subject, and, roughly, its classification into that which is positively established as fact, that which is doubtful or unproved and that which remains to be learned in order to combat air-derived occupational diseases.

Investigations in the cinchona alkaloid field, especially of the chemotherapy of pneumonia, have been continued in the Institute's department of research in pure chemistry, of which L. H. Cretcher is the head and C. L. Butler is senior fellow. In view of the very promising experimental and preliminary clinical results reported last year by the medical collaborators, W. W. G. Maclachlan, H. H. Permar, John M. Johnson and H. H. Burchel, using hydroxyethylapocupreine, more intensive study of this substance has been pursued, and a new and more efficient method of preparing it and other hydroxyalkyl ethers of cinchona alkaloids has been devised. Preparation work has been carried on mainly by B. L. Souther, Mary Hostler and Mary Clapp.

The highly desirable properties of hydroxyethylapocupreine as an antipneumococcic drug, such as high bacteriostatic activity *in vitro*, high protective action *in vivo* (mice), very low toxicity and absence of eye damage, have been confirmed by the medical group. Further clinical tests on a larger number of patients

have been made. While it is fully realized that caution in interpreting clinical data is essential, the present indication from the proportion of recoveries in these treated cases is that the drug has a highly beneficial effect upon the course of pneumonia. The final decision as to its real effectiveness will come only after analysis of many more treated cases than are now available.

The Institute participated in the compilation of the Eleventh Decennial Revision of the United States Pharmacopoeia, which was issued on January 1, 1936, and became official on June 1. In conformity with the policy of the U. S. Pharmacopoeial Convention, the work of revision has continued in order to keep abreast of commercial trends and therapeutic developments and to make available to all users the latest scientific information on the standardization of medicinal agents. The findings of the Revision Committee will be published from time to time as supplements to the Pharmacopoeia and will have official standing from those dates. Study of the official organic chemicals is continuing under the chairmanship of G. D. Beal with the aid of a grant from the Pharmacopoeial Convention. M. W. Green has been appointed as assistant in the Institute's department of research in pure chemistry under this grant.

Research on dental caries has been continued by the fellowship of the Buhl Foundation, which is headed by G. J. Cox with W. E. Walker and Sara F. Dixon as assistants. The study has centered upon the two fundamental aspects of nutritional control of dental caries, namely, (1) the formation of teeth immune to caries and (2) the arrest of decay in existing cavities. The nutritional factors which confer caries immunity may be, but are not necessarily, the same as those which arrest the progress of decay.

The bacteriological and serological investigations started several years ago at the suggestion of Dr. C. B. Schildecker have been continued on an enlarged scale during the year. This work, which is under the general supervision of Dr. R. R. Mellon, director of the Institute of Pathology of the Western Pennsylvania Hospital, is supported by Mellon Institute. The biochemical group (A. P. Locke, with the assistance of Rose B. Locke, Rhoda J. Bragdon and William Thompson) is concerned with the rôle of host factors in pneumococcic infections. The bacteriologists (P. B. Hadley, aided by Faith P. Hadley, F. B. Cooper, Paul Gross, Louise Peebles, L. R. Shinn and Marion L. Lewis) are investigating the development and dispensing of types I and II pneumonia serums and the mechanism of action of an antistreptococcus serum.

SPECIAL ARTICLES

PIMELIC ACID AS A GROWTH ACCESSORY FACTOR FOR A STRAIN OF THE DIPHTHERIA BACILLUS[1]

STUDIES on the nutritional requirements of certain strains of the diphtheria bacillus, which have been carried out during the last few years in this laboratory,[2,3,4,5] have served to indicate the general nature of the materials which must be supplied in order to obtain maximal growth of these organisms. In addition to suitable inorganic ions, these include (1) a readily available source of energy—*i.e.*, glycerol, ethyl alcohol, lactic acid, etc.; (2) certain amino acids, varying individually somewhat from one strain of the organism to another; and (3) one or more substances occurring in meat extract or in extractives from other tissues.

It has already been shown[4] that a boiling water extract of liver offers an adequate source of these latter growth-stimulating materials, a considerable proportion passing into the filtrate after vacuum concentration and precipitation with alcohol, and, further, that from such a solution, after removal of the alcohol in vacuo, the substances in question are readily adsorbed on charcoal and may be eluted from it with acid alcohol.[6]

This eluted material has been purified in a number of ways, keeping in mind always that more than one substance may well be involved. It was eventually found that a separation into two fractions could be accomplished, neither of which alone, in any concentration, would duplicate the effect of small amounts of the mixture with our test strain. This separation was brought about by repeatedly extracting the strongly acidified eluate with ether. The ethereal solution and the residual aqueous layer constituted the two fractions. Again, the possible multiplicity of active substances in one or both of these fractions has had to be kept in mind.

Recalling the work of Pappenheimer[7] in isolating

[1] From the Department of Bacteriology and Immunology, Harvard University Medical School, Boston.

[2] J. H. Mueller, K. S. Klise, E. F. Porter and A. Graybiel, *Jour. Bact.*, 25: 509, 1933.

[3] J. H. Mueller, *Jour. Bact.*, 29: 515, 1935.

[4] J. H. Mueller, *Jour. Bact.*, 30: 513, 1935.

[5] J. H. Mueller and I. Kapnick, *Jour. Bact.*, 30: 525, 1935.

[6] The writer is indebted to Dr. Y. Subba Row, of the Department of Biochemistry of the Harvard University Medical School, and to the Lederle Company, Pearl River, New York, for considerable quantities of liver extract concentrates used in this work; and to Dr. Subba Row, also, for a great deal of active assistance and advice.

the "sporogenes vitamin" of Knight and Fildes,[8] the material contained in the ether extract was sought and found to be present in urine; and here again, as with the sporogenes vitamin, in considerably greater concentration in the urine of herbivors than of man. When calculated back to a liver tissue equivalent, horses' or cows' urine evidently contained a much higher concentration than liver. The isolation of the active material from cows' urine was therefore undertaken.

From one hundred gallons of cows' urine, it is now possible to report the isolation of about 0.25 gram of pimelic acid. This has been identified, first in a preliminary way by titration equivalent, carbon and hydrogen determinations and molecular weight by the camphor method of A. Rast. Identification was completed by mixed melting point determinations with commercial pimelic acid (Eastman) and by mixed melting points of the phenyl-phenacyl esters of the natural and synthetic acids. Physiological identity has been established by the completely satisfactory substitution of commercial pimelic acid for the active material of urine in growth tests with our strain of the diphtheria bacillus.

When added to a suitable control medium, pimelic acid in a concentration as low as 0.01 gamma (1×10^{-8} g) per cc of medium gives a recognizable increase in growth over the control, and a maximum effect is reached with about ten times this quantity. The control alone, containing inorganic salts, lactic acid, an acid hydrolysate of casein enriched by cystine and glutamic acid and the ether insoluble fraction of the liver eluate regularly permits rather poor, scanty growth of our test strain, amounting to about 0.8 to 0.9 mg bacterial nitrogen after three days' growth on 10 cc of the medium. This is increased by pimelic acid to more than 3.0 mg, which—grossly—is a heavy, well-developed pellicle. Increasing the concentration of pimelic acid many times, up to 1.0 mg per cc, has no further effect, either inhibitory or otherwise.

As far as the writer can learn, pimelic acid has not previously been described as a constituent of urine or of animal tissues. Naturally, the possibility exists that the active acid present in liver tissue is not identical with that isolated from urine, and if sufficient material becomes available in the course of the further study of the ether insoluble material now under way, an attempt will be made to settle this point.

A complete report of these experiments will shortly be made elsewhere.

J. HOWARD MUELLER

[7] A. W. Pappenheimer, Jr., *Biochem. Jour.*, 29: 2057, 1935.

[8] B. C. J. G. Knight and P. Fildes, *Brit. Jour. Exp. Path.*, 14: 112, 1933.

BIOLOGICAL ASSAYS FOR FLAVIN AND DERMATITIS FACTOR(S)

I. A SPECIFIC method for the assay of flavin has been found necessary to study the factors in the vitamin G complex. The following procedure was useful as a practical measure of the amount of flavin in biological materials. Albino rats (16 days old) were placed with their mother on a diet consisting of 35 per cent. casein (Labco), 56 per cent. sucrose, 5 per cent. Crisco, 4 per cent. Osborne and Mendel salt mixture and a cod liver oil concentrate (White's) supplying 20 units of vitamin A and 4 units of vitamin D per gram of diet. The rats were weaned at 21 days and placed in separate cages. An extract of rice polishings[1] (90 mg) was supplied daily to provide vitamin B_1 (6 I.U.) and the factor(s) in the vitamin G complex other than flavin. Selected dose levels of the material to be assayed for flavin were fed daily to groups of six rats. The positive control rats received 15 micrograms of pure flavin (Labco) which permitted an average growth rate of 1.5–2.0 g daily for four, six or eight weeks. Concentrated extracts of yeast have been assayed by this method.

Negative control rats showed a characteristic cessation of growth at the end of four weeks. A second type of assay was based on the recovery of these stunted animals with resumption of growth at an average rate of 2.0 g per day for two weeks when 15 micrograms of pure flavin were administered with the daily supplement. This method was more sensitive to lower levels of flavin,[2] but the time required for the complete assay was longer. Extreme depletion (5 to 6 weeks) has produced alopecia and dermal lesions which were cured in approximately four weeks with pure flavin.

II. The same two methods of assay have been employed to measure the factor(s), other than flavin in the vitamin G complex. Flavin (15 micrograms) and vitamin B_1 (6 I.U.) were furnished as daily supplements, together with selected dose levels of the test material, such as an extract of wheat. The rice polishings concentrate[3] (90 mg) as a standard control, permitted an average growth rate of 1.5 to 2.0 g daily for four to eight weeks.

In the second type of assay 30 micrograms of crystalline B_1 (Merck) and 15 micrograms of flavin were fed as daily supplements during the period (3 to 4 weeks) of depletion. The rice polishings concentrate, which also has been shown to contain the dietary

[1] C. A. Cook and R. Carroll, *Ind. and Eng. Chem.*, 28: 741, 1936.

[2] S. Ansbacher *et al.*, *Jour. Nutrition*, 11: 401, 1936.

[3] "Ryzamin-B" (Burroughs Wellcome and Co., (U. S. A.) Inc.).

extrinsic factor,[4] was then substituted for the crystalline B_1 in equivalent amounts. This concentrate (75 to 90 mg) plus the flavin produced a resumption of growth at an average rate of 2.3 to 2.6 g per day, respectively, for four weeks, while a lower dose level (56 mg) yielded 1.3 g per day for the same period. The different growth rates were not due to a variation of the vitamin B_1 intake, which was maintained at a constant level (6 I.U.).

Negative control rats supplied with only B_1 and flavin developed a progressive dermatitis in about five weeks, and several animals died. The swollen and inflamed paws have been cured by administration of the rice polishings concentrate which contained the dermatitis factor(s). The biological factor(s) was stable when the concentrate was subjected to ultraviolet irradiation but was partially destroyed by treatment in an autoclave.

With both types of assay the daily supplements were designed to provide optimal quantities of vitamins so that inadvertent additions with the test materials would not affect the growth rate beyond the biological error. Coprophagy did not become a problem. These methods are being used to assay experimental fractions in a study of the biological factor(s) which have a reputed relation to pellagra and pernicious anemia.

CHARLES A. COOK
MIRIAM F. CLARKE
AMOS E. LIGHT

BURROUGHS WELLCOME AND CO., U. S. A.
EXPERIMENTAL RESEARCH LABORATORIES
TUCKAHOE, N. Y.

THE DISTRIBUTION OF GENE FREQUENCIES IN POPULATIONS

THE effects of the various evolutionary factors can be reduced to common terms by considering the rates of change which they tend to bring about in the relative frequencies of alleles within a population. In the absence of such factors, there is a constancy of gene frequencies from the symmetry of the Mendelian mechanism. The frequency (q) of a given gene changes at the rate

$$\Delta q = -uq + v(1-q) - m(q - q_t) + \frac{q(1-q)}{2}\frac{\partial}{\partial q}\log \overline{W}$$

where u is the rate of mutation of the gene in question, v is the rate of mutation to it from its alleles, m is the effective amount of exchange between the local population under consideration and the species as a whole (gene frequency q_t), and $\overline{W}$ is the mean selective value of the array of genotypes characteristic of this population. Gene frequency is in equilibrium (stable or otherwise) at any point at which $\Delta q = 0$ except for variation due to the accidents of sampling among the gametes. The sampling variance for one generation is $\frac{q(1-q)}{2N}$ where N is the effective size of the breeding population. The pressure toward a stable equilibrium in value of q, due to mutation, crossbreeding and selection (assuming persistence of the same conditions for a long period), and the divergent tendency due to inbreeding should between them determine a certain probability distribution of values of q for the local population considered. The following formula is reached, assuming that the selective effects of the gene in question are independent of those of other genes.

$$\varphi(q) = \frac{Ce^{4N\int \frac{\Delta q\, dq}{q(1-q)}}}{q(1-q)} = C\,\overline{W}^{2N} q^{4N[mq_t + v]-1} (1-q)^{4N[m(1-q_t)+u]-1}$$

More generally, selective values depend on the interactions of the entire system of genes. It is the harmonious development of all characteristics that determines the success of an organism, not the absolute grades of the separate characters and still less the composition with respect to a single series of alleles. The mean selective values, $\overline{W}$, of populations characterized by different sets of gene frequencies form a multidimensional surface which in general has many peaks. The joint distribution of the gene frequencies is given by the formula

$$\varphi(q_1, q_2 \cdots q_n) = C\,\overline{W}^{2N} \prod_{i=1}^{n} q_i^{4N[mq_t + v_i]-1} (1-q_i)^{4N[m(1-q_t)+u_i]-1}$$

SEWALL WRIGHT

UNIVERSITY OF CHICAGO

BOOKS RECEIVED

GAMOW, G. *Structure of Atomic Nuclei and Nuclear Transformations.* (Second edition of *Constitution of Atomic Nuclei and Radioactivity.*) Pp. xii + 271. 70 figures. Oxford University Press. $6.00.

JOHANNSEN, ALBERT. *A Descriptive Petrography of the Igneous Rocks.* Vol. III, *The Intermediate Rocks.* Pp. xiv + 360. 178 figures. University of Chicago Press. $4.50.

NORTHRUP, E. F. *Zero to Eighty.* Pp. viii + 283. 13 figures. Scientific Publishing Co. $3.00.

PETERSEN, WILLIAM F. *The Patient and the Weather.* Vol. IV, Part 1, *Organic Disease; Cardio-Vascular-Renal Disease.* Pp. xxxiv + 663. 448 figures. Edwards Brothers. $10.00.

SHELFORD, VICTOR E. *Animal Communities in Temperate America.* Pp. xiii + 368. 306 figures. University of Chicago Press. $3.00.

UBBELOHDE, A. R. *An Introduction to Modern Thermodynamical Principles.* Pp. 131. 11 figures. Oxford University Press. $3.00.

WELLS, VOLNEY H. *First Year College Mathematics.* Part II, *Mathematical Analysis.* Pp. ix + 276. [illegible] figures. Van Nostrand.

[4] D. K. Miller and C. P. Rhoads, *New Eng. Jour. Med.*, 211: 921, 1934.

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A HALF CENTURY OF AMERICAN MEDICINE[1]

By Dr. SIMON FLEXNER

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

By a happy coincidence it is just a half-century since I entered the University School of Medicine at Louisville as a student. For fifty years, therefore, I have been an observer of the medical developments taking place in this country, and during much of this time I have also followed the developments going on abroad. It is my purpose on this occasion to attempt a brief and rapid review of American medicine of this period in relation to European medicine as it existed at the same time.

But first I must express to you the happiness I feel in returning here to my Alma Mater and to the city of my birth and young manhood. I am moved to salute you on the celebration of the hundredth anniversary of your foundation, to congratulate you on your past, and to wish you ever greater achievements in the future.

The early history of the Louisville Medical School is an integral part of the history of the American frontier and the winning of the West. Abler and better-informed writers have recorded the beginnings of the school, brought it into relation with Transylvania University, from which the first nucleus of its faculties came, and followed its later vicissitudes. The school was an important link in that historical chain of peripatetic schools which, before the middle of the last century, attracted the experienced physicians and surgeons of the day who wandered up and down the country from east to west, doing their part, and a very significant part, in subduing the wilderness. It is a pleasure and an inspiration to recall some of the remarkable men who taught here, among whom were Daniel Drake, Samuel D. Gross, Austin Flint, Elisha

[1] Address delivered on April 3, 1937, at the celebration of the one hundredth anniversary of the founding of the School of Medicine of the University of Louisville.

E. Bartlett, Benjamin Silliman, Jr., Charles Caldwell and the elder Yandell and Palmer. These men left an impress on the school which endured long beyond their days. They anticipated the later practice of calling outstanding teachers from one institution to another, too long suspended subsequently when the schools had hardened into fixed institutions, each with its local faculty. Indeed, this innovation waited full half a century until the medical schools of the country progressed sufficiently to achieve real university status.

Fifty years ago the pioneering period in medical education had come to an end. The riding of the circuit by wandering teachers was over. One can picture the glamor of the free life led by these men in their young manhood as they rode without haste through a primeval and often beautiful country, and the thrill and pleasure they experienced in meeting one another again after months or even years of separation. That a warm companionship grew up among them could be safely assumed, and letters of the period tell this story. Elisha Bartlett, one of the rarest and most delightful of men, who taught at the Berkshire Medical Institute in Pittsfield, Mass., as well as in Louisville, wrote in 1836, referring to Willard Parker: "He was in to see me a few minutes after my arrival, with his sunny face and hearty welcome. It does one good to meet such men." Bartlett, by the way, taught in nine schools, as also did another peripatetic, John Delamater, the founder of the Medical College of Western Reserve University. That the peripatetic doctors, when they were men of ability, should have become highly experienced teachers follows from their unexampled opportunities. They enriched, therefore, the medical literature of their time and some of their writings have become the classics of our profession.

The Louisville Medical School in my day still bore the impress of these teachers. It was a school in which the lecture was everything. Within the brief compass of four winter months the whole medical lore was unfolded in discourses following one another in bewildering sequence through a succession of long days; and lest the wisdom imparted should exceed the student's power of retention, the lectures were repeated precisely during a second year, at the end of which graduation with the degree of doctor of medicine was all but automatic. Of laboratory instruction there was none; the anatomical laboratory provided the one place where practical instruction was given, and yet the students managed somehow to become doctors, and ever so often good doctors at that.[2]

The saving grace was the preceptorial system, virtually an apprenticeship, in which older, experienced men taught the methods of their art to the student doctors during the eight months between courses. The apprentice served his master as druggist, operation assistant, and in many other ways; rode with him on his rounds, took his place when he was ill and at times in the blustery nights, and supplemented him when epidemics swept the countryside. That unusual skill should sometimes have crowned so imperfect an educational discipline justifies the comment made by an eminent teacher, Dr. William H. Welch, himself a product of the old order, that "the results were often better than the system." A profession based on so faulty a system of education could not survive in a country developing materially, becoming conscious of its intellectual deficiencies and sensitive to the opinion of the larger world of which it now formed an integral part. That forward steps should originate in the East, longer settled and more prosperous, and that the first step should have been taken at Harvard College need excite no wonder. One of the revolutionary acts set in motion by President Eliot when he took office in 1869 was the regeneration of the Harvard Medical School, which, to all intents and purposes, corresponded to this school as I knew it just twenty years later. President Eliot improved the student body by raising the entrance requirements and the school by prolonging and grading the courses of instruction and by introducing practical methods of clinical teaching and even laboratory training. But the Harvard school, like all the other schools of the period, lived on students' fees. By raising the standards, giving the school a real university status, and by arousing public interest in the reforms undertaken, President Eliot soon secured aid from the citizens, justifying his dictum that "the first step toward obtaining an endowment is to deserve it."

The decade from 1870 to 1880 is a highly significant one in the medical educational history of this country. It was a preparatory period, the full effects of which were to be realized a few years later. The first ventures in medical instruction made in colonial times were sound. They were based by John Morgan and his associates in Philadelphia on the Scotch system; and the rules laid down by them as qualifications for the "bachelor's degree in physic" arouse admiration even to-day; they include some knowledge of the Latin tongue and such branches of mathematics and natural and experimental philosophy as shall be judged requisite to a medical education. A hundred years were to elapse before a corresponding standard of educational

[2] In my day there was no pathology and of course no bacteriology at the Medical School. In 1889 Dr. Edward R. Palmer, the professor of physiology, announced a course of lectures in bacteriology. They consisted of readings from a fascinating small book, Prudden's "Story of the Bacteria," which had just appeared. I present this book in its first edition to your view. Need I add that I bought the book to read instead of attending lectures in order to hear it read in weekly instalments. This was doubtless the beginning of bacteriology in the school.

preparation for the study of medicine was again instituted.

The modern developments in American medicine are of German origin. The Scotch, English and French schools had attracted ambitious American students in the eighteenth and early part of the nineteenth centuries. The rise of the German medical schools to pre-eminence began with the appearance on the scene of two remarkable teachers, near contemporaries. One was Johannes Müller, born in 1801, and the other Justus von Liebig, born in 1803. Müller, the son of a shoemaker of Coblentz, was anatomist, physiologist and pathologist. He studied at Bonn and at Berlin and became professor in both these universities, and was the teacher of great men, among whom were Schwann, the founder of the cell theory, Henle, the anatomist who formulated precisely in 1840 the germ doctrine of disease, Traube, the experimental pathologist, Helmholtz, the physicist and physiologist, and Virchow, the originator of the cell doctrine in and the father of modern pathology. Liebig's father dealt in colors and with the aid of his small son manufactured them by the elementary methods of the day. Chemistry thus came naturally to the youth who was to establish the student's laboratory, a decisive factor in making German science, including medical science, supreme. As early as 1824, Purkinje, the physiologist, started a laboratory in his own house in Breslau, but it was in Giessen in 1825 that the important step was taken when Liebig's laboratory was opened there in the university. It is interesting to recall that it was Alexander von Humboldt, the insatiable traveler, who was responsible for this great innovation. The gifted young Liebig, in 1822 at the age of nineteen, studied in Paris. At that time there did not exist in Paris, or indeed anywhere in the world, a single public laboratory for students in chemistry or physics. Through private influence Liebig secured entrance to the personal laboratory of Gaultier de Claubry, where he worked on explosives and by chance met Humboldt, who was deeply impressed by him. Thereafter all doors and all laboratories opened to him as if by magic, and he was soon at work with the eminent Gay-Lussac; and it was Humboldt also who brought Liebig to the little University of Giessen.

Liebig's chemical laboratory quickly became celebrated and copied by the German universities generally and in other countries. The first two men who devoted themselves entirely to laboratory teaching in this country in a medical subject were Henry P. Bowditch at the Harvard Medical School and Newell Martin at the Johns Hopkins University. This was in the years from 1870 to 1876. Both had studied abroad, Bowditch at Leipzig with Karl Ludwig and Martin at Cambridge with Michael Foster, the founder of the English school of physiology. There had, however, been a full-time teacher at the Harvard Medical School before Bowditch. Oliver Wendell Holmes taught anatomy and physiology there from 1847 to 1871, holding, as he later said, "not a chair, but a settee."

In the decades from 1860 to 1890 pathology in Germany reached its height under the stimulus given it first by Virchow and then by Cohnheim. Pathological anatomy was everywhere assiduously pursued, but it was at Berlin under Virchow and the clinical teacher Traube that pathological experiment was placed in its impregnable position in the development of pathological physiology. But in the seventies another school of great strength in experimental or physiological pathology arose at Breslau under Cohnheim, a pupil of Virchow's who also was a pupil of the physiologist and chemist Kühne of Heidelberg. These two centers—Berlin and Breslau—vied with the new German university at Strassburg in attracting American students, and hither in the middle seventies went such men, afterwards to become teachers and investigators in pathology, as William H. Welch and T. Mitchell Prudden.

They returned to this country before 1880 and neither of them found an opportunity to teach pathology in an adequate way. Hence they engaged in a variety of pursuits to gain a livelihood—practicing medicine, performing autopsies, quizzing medical students, doing a kind of hack literary work, with only odds and ends of time left for practicing their chosen profession.

But great changes were imminent. A small beginning was soon made at Bellevue Hospital in New York, where Dr. Welch offered the first course in microscopical pathology given in America and where he met Austin Flint, who was not long in discovering his unusual abilities. I like to connect these important events with the history of the Louisville Medical School, at which Austin Flint taught in pioneer days. It is a fact of history that Welch wrote the pathology for the fifth and sixth editions of Flint's "Practice of Medicine" and in so doing produced one of the first treatises on pathology worthy of the name in this country. The sections on pathology in the sixth edition have not, in my opinion, been surpassed in any language and they are unique in the breadth of treatment given them. This edition was published in 1886, or in the midst of the Koch or bacteriological period, so that it covers not only pathology in the usual sense, but also pathological physiology reflecting the Cohnheim influence and embodies the principles of the new bacteriology. Prudden started in practice in New Haven, but in 1878 was called to the College of Physicians and Surgeons in New York, where he opened the first

pathological laboratory in that school in a basement room which had been an ice-cream parlor. It was not until 1884 that Welch was called to Baltimore and not until 1892 that Councilman, who had studied with Cohnheim in 1883, was called to Harvard Medical School to fill the chair of pathology, the first professorship in this institution to be filled from outside Boston.

More important, however, for the impending developments was the founding of the Johns Hopkins University and Hospital. Mr. Hopkins, a Baltimore merchant, left his entire fortune of seven million dollars to the support of the university and the hospital. Daniel C. Gilman was made president of the university. A medical school, part of the university and attached to the hospital, was in contemplation. The university opened in 1876, and Thomas H. Huxley delivered the inaugural address, in the course of which he said:

> At present young men come to the medical schools without a conception of even the elements of science. They learn for the first time that there are such sciences as physics and chemistry and physiology and are introduced to anatomy as a new thing. . . . There is not the least reason why this should be so. . . . There is not the slightest difficulty in giving sound elementary instruction in physics and chemistry and the elements of physiology in the ordinary schools. . . .

These fateful words fell on prepared soil. President Gilman had graduated from the Sheffield Scientific School of Yale College and in 1870 was instrumental in arranging there a premedical course in the physical sciences. It was natural, therefore, that such a course should be offered immediately at the Johns Hopkins University; moreover, it was supplemented with courses in modern languages. Prudden had been a student at the Sheffield Scientific School in the early seventies and had taken, as part of his regular instruction, this preliminary medical training, and Welch, having graduated from the arts college, returned after a year of school teaching to spend an extra year at the Sheffield School before entering on the study of medicine at the College of Physicians and Surgeons in New York.

The decade 1880 to 1890 has been called "the most wonderful, perhaps, in the history of medicine." Pasteur's famous labors were drawing to a close with the dramatic demonstration in 1885 on the Alsatian lad, Joseph Meister, that he had perfected a means of preventing rabies or hydrophobia. Koch and his pupils had discovered the germ causes of tuberculosis, Asiatic cholera, diphtheria, typhoid fever and other infectious diseases. A revolution in medical thought had been brought about by the discoveries of this epoch, and those living to-day can hardly realize the enthusiasm and youthful spirits which were stirred by these advances not only among medical men but among the public.

The eastern medical schools and the University of Michigan had responded to these influences. The most significant advance had been made at the Johns Hopkins University, to which Dr. Welch, a pupil of von Recklinghausen, Ludwig and Cohnheim, was called as professor of pathology.[3] The Johns Hopkins Hospital opened its doors to patients in 1889, the entire major clinical staff having come from outside Baltimore. The names of these men—Osler, Halsted, Kelly—have become household words among doctors. This was an innovation indeed. For the first time in educational history in this country a medical faculty had been chosen on strictly university lines.

Untoward circumstances delayed the opening of the medical school for another five years. When it was established the laboratory faculty was chosen on the same broad principles of scientific attainments. Moreover, the requirements for entrance on medical studies adopted were essentially those laid down in Professor Huxley's address, and the school avowedly accepted the thesis that its responsibility for the instruction of students and the training of doctors was no greater than its responsibility for the advancement of knowledge by research.

By the end of the nineteenth century several medical colleges were equipped with laboratories manned by specially trained teachers and had secured larger clinical facilities; and at the beginning of the twentieth century the pursuit of science, including medical science, had been given a great impetus in this country through the intelligent action of certain laymen. The Rockefeller Institute for Medical Research was founded in 1901 and the Carnegie Institution of Washington in 1902.

Now there is nothing peculiar about the medical sciences. They are only biology, chemistry and physics directed toward particular ends, namely, the understanding of disease and its prevention and cure. The successful prosecution of medical research depends, therefore, on knowledge of the underlying sciences. Medicine had progressed so far in America because

[3] Pathology had a development in America differing from its German prototype. It included normal as well as pathological microscopy (histology), bacteriology during the Koch era, experimental medicine or pathological physiology, and sometimes even clinical microscopy. The several subjects included ranged about the microscope, which was used in all. Whether pathological physiology became a part of the chair depended on the particular master with whom the occupant had studied in Germany. It was not until academic or full-time clinical chairs were established at the Hospital of the Rockefeller Institute in 1910 and at the Johns Hopkins Medical School in 1914 that experimental medicine was studied in the clinic as Ludwig Traube had done in Berlin before 1850.

the fundamental sciences fortunately had already been cultivated, although inadequately. According to ordinary perceptions it was little hazardous to found an institution for pure research in the physical sciences and extremely adventurous to attempt to do this for medicine. I doubt whether any medical man would have made this venture. To do so called for the courage of laymen who managed somehow to see the wood unobstructed by the trees. Let us recall that the bacteriological era from 1880 to 1890 had been succeeded by the immunological decade of 1890 to 1900, which saw diphtheria and tetanus or lockjaw robbed of their main terrors by antitoxin and typhoid fever prevented by inoculation. The times were stirring ones and hope for the eventual and not too long deferred conquest of the germ-caused diseases ran high.

The higher medical education already achieved in the last quarter of the nineteenth century, although not yet on a country-wide basis, made possible the experiment about to be undertaken with an institution devoted wholly to medical research. In retrospect a parallel can now be discerned between the establishment of the Rockefeller Institute and the Carnegie Institution in this country and the founding of the learned societies—the Academy of Sciences in France and the Royal Society in England—in the seventeenth century. In both instances the demands of scientific growth and exploration had outgrown the provisions in the universities. A broader base of operations was necessary; the encroachments upon the time of teachers by enlarging routine duties had become menacing; the requirements in elaborate and expensive apparatus had often exceeded the abilities of the universities to supply the needs. The new institutions, which in time came to be generously endowed, filled the gap, and they are justifying themselves as the country's opportunities enlarge more and more, by drawing able men from the universities, enhancing their training and often returning them to the universities increased in power, skill and value.[4]

In the early part of the twentieth century many medical schools were still far behind the advancement which had taken place in some of the more favorably situated institutions. Two logical developments now took place. The Council on Medical Education of the American Medical Association and the Association of American Medical Colleges entered the field shortly before 1910 and succeeded in leading professional opinion on medical standards and, by exerting a kind of moral pressure, brought about much-needed reforms in the backward schools. A second factor was the Carnegie Foundation report on medical education issued in 1910. This report, which many of you will recall, was prepared by my brother, Abraham Flexner, and speaking of it in his Harvey Lecture of 1915, Dr. Welch states: "I consider it to be one of the most remarkable and influential publications in educational literature. It has had not only a large influence upon professional opinion, but especially a large influence on the universities and on public opinion. It is to be characterized as one of the important factors which indicate this remarkable advance in medical education."

Philanthropic organizations now entered on the liberal support of medicine. The General Education Board and the Rockefeller Foundation especially contributed large sums to the further strengthening of the existing stronger schools, the regeneration of others and the establishment of new schools at strategic geographic locations; and the general public responded also, so that in an incredibly short space of time a vast improvement in the medical schools in all parts of the country took place. President Eliot's remark that "the first step toward obtaining an endowment is to deserve it" had been shown to be more than ever true.

The rewarding nature of endowments to advance medical education and research has been shown in many concrete instances; and one could scarcely cite a more impressive example of the power of modern medicine to abate anxiety and to remove the danger of disastrous epidemics than your own recent experience in the confused days of the flood calamity by the application of bacteriological methods of the prevention of disease.

The laboratory branches of anatomy, physiology, pharmacology and biochemistry were well advanced in this country before the end of the second decade of this century. Many more of the medical schools had established laboratories for teaching and for research in charge of trained teachers. Hospitals had been improved and clinical instruction made more effective. But at its best the clinic lagged behind the laboratory and usually was in charge of local practitioners engrossed with practice. Selection according to special qualifications, as was now customary with the laboratory, was highly exceptional. It was not until 1912 that a clinical professorial chair at Harvard Medical School was filled from the outside. Finances had much to do with this defect, but there were and still are other difficulties not yet overcome.

The clinical side of medical education is the central

[4] Germany, from which ambitious young American doctors drew inspiration and training between 1870 and 1900, turned to the United States for the model of its institution of scientific research established at the end of the first decade of the twentieth century. The Kaiser Wilhelm Institute, with its 30 different laboratories, which has just celebrated its twenty-fifth anniversary, is avowedly modeled on the Rockefeller Institute and the Carnegie Institution, founded ten years earlier.

feature toward which the training in the laboratory branches aims. This is not to say that the laboratory subjects have not an interest and scientific purpose of their own. Far less had been done to make the clinic branches strong and effective than had been done for the laboratory subjects. Moreover, the load of responsibilities on the clinical teacher is far heavier than on the laboratory teacher. A head of a principal clinical department is responsible for the patients, for the teaching and in theory for the stimulation of research, while he is also engaged in the onerous and absorbing practice of medicine. The burden is heavier than any one can bear in the modern medical school, where teaching and research and the care of patients in the hospital now involve the many methods of precision which are constantly increasing in number and complexity.

The recognition of the difficulties just alluded to led the Johns Hopkins Medical School in 1914 to a courageous move. Through financial aid provided by the General Education Board, chairs of academic, sometimes called full-time, instruction were established in medicine, surgery, obstetrics and pediatrics. Several other schools have now found the means to institute similar academic professorships. The precise form taken by these new establishments varies somewhat, as is desirable in order to determine what is the most successful and practicable system. The academic teachers are distinguished from the usual clinical teachers mainly through the command of their time for more intensive study of clinical problems arising in connection with patients and for the conduct of laboratory investigations bearing on problems in clinical medicine. No school has tried to or can or should dispense with part-time clinical teachers, who continue to carry as they always have done an important and substantial part of the instruction of students.[5]

The academic clinical professorship is an American invention, but it is attracting the attention and the study of foreign universities. Only a short time ago Oxford University received a gift of ten million dollars for the purpose of endowing these professorships in medicine and surgery.

Up to the last decade of the nineteenth century no scientific medical journal existed in this country. This fact alone speaks for the state of medical science in America forty years ago. The *Journal of Experimental Medicine* was founded in 1896, with Dr. William H. Welch as editor. There was much doubt expressed whether there were enough technically scientific papers being produced to keep the journal alive. No limit was set as to the kinds of scientific papers acceptable; the only exclusion contemplated was that of the practical, clinical paper for which other means of publication already existed. As experience quickly proved, the potential scientific medical richness of the country had been underestimated. In a very few years, the *American Journal of Physiology* was started, and then successively followed journals devoted to pharmacology and therapeutics, infectious diseases, biochemistry, bacteriology, immunology, etc. I have examined the Quarterly Cumulative Index Medicus, and have marked more than thirty journals of technical scientific medical character now being published in this country. The first medical periodical to be published in America was the *Medical Repository*, started in 1797. Just a hundred years were to elapse between the publication of this clinical journal and that of the first scientific journal in this country.

Medicine to most of us means human disease. The definition is a narrow and insufficient one, as all living things suffer from disease. There is no line of division between disease in man and in the lower animals and in plants. Disease in man has of course a special importance for us, just as, economically considered, certain diseases of animals and plants have a higher value than others since man is so dependent on animals and plants for his survival and comforts. But to the true pathologist disease, wherever it appears, presents a series of challenging problems, the solution of any one of which will aid in the solution of others. The pathologist looks at the diseases of man, the lower animals and plants as forming an inseparable chain, and as the knowledge of the nature and causes of diseases continues to grow, this chain becomes more and more intricate and interrelated. The growth of medical knowledge and the improvements in medical education in this country in the last half century have influenced federal and state governments in providing schools in which the diseases of animals and plants can be investigated as human diseases are studied. As early as 1884 the federal government established the Bureau of Animal Industry and in 1887 the enactment of the Hatch act created the agricultural experiment stations. It was at the Bureau of Animal Industry that Dr. Theobald Smith, a medical graduate, made some of his most important discoveries, and although they related to diseases of animals, they affected in a remarkable and beneficent manner the development of human pathology.

The centennial of the founding of the Army Medical Library was celebrated a few months ago. The history of that library is bound up with the history of American medicine in the last half century in a highly important way. Scientific knowledge including medical knowledge is contributed to by all countries; a great library is essential, therefore, to the growth of

[5] This is not to say that clinical teachers did not in some instances conduct experimental investigations before this change. Halsted and his pupils are a notable case in point.

the scientific spirit. Now the Army Medical Library is supreme among medical libraries of the world, and a part of this supremacy arises from the publication of the Index Catalogue, four series of which have appeared between 1880 and 1936. This catalogue is one of the most monumental if not the most monumental bibliographical work ever produced. The history of the library has been told recently by Major Hume, the librarian. In this very interesting paper he reports a conversation with Dr. Welch, who was a regular user of the library, which bears on our theme and which I grasp eagerly in bringing this address to a close. In response to an inquiry, Dr. Welch said:

I have been asked on more than one occasion what have been the really great contributions of this country to medical knowledge. I have given the subject some thought and think that four should be named:

(1) The discovery of anesthesia;

(2) The discovery of insect transmission of disease;

(3) The development of the modern public health laboratory . . .

(4) The Army Medical Library and its Index Catalogue.

The discovery of anesthesia falls outside the period we are considering. Theobald Smith discovered the tick transmission of Texas fever of cattle at the Bureau of Animal Industry in 1890, and in so doing opened one of the most important chapters in modern pathology. We need only think of the mosquito carriage of malaria and yellow fever to appreciate the tremendous significance of the discovery. And virus and still other diseases of animals and plants also are carried by insect agents.[6]

The development of the public health laboratory had its beginning in 1887, or just fifty years ago, at the Federal Marine Hospital on Staten Island, being transferred to Washington in 1891. The appearance of cholera in New York Harbor in 1892 led to the opening of the first municipal laboratory, and between 1890 and 1894 the diphtheria diagnostic and antitoxin and the tuberculosis diagnostic laboratory was established in New York City under Dr. Hermann M. Biggs and Dr. William H. Park. From these modest beginnings public health laboratories, an essential adjunct to public health administration, have spread over the entire country, being supported by state, county and city funds. The campaign to eradicate the hookworm disease, financed by Mr. Rockefeller in 1910, gave a great impetus to the founding and improving of such laboratories in the southern states.

To these four great American contributions to medicine made during the last half-century I would add a fifth which is so new and indeed so startling that we can only begin to speculate on its importance. It has arisen out of the application of methods, some only just perfected, to the study of the agents causing the infectious diseases. The first advance I shall refer to is the discovery that the specific properties of disease-producing bacteria are of chemical origin. The active chemicals are crystalline in nature and the germs deprived of them become harmless. They take part not only in producing disease, but also in producing immunity from disease.

The second advance is as remarkable, but in an entirely different way. It relates to the viruses, those invisible, elusive, disease-producing agents of which one hears so much to-day. In number they exceed apparently the disease-producing bacteria, and like the latter are responsible for destructive diseases in all orders of living things. As an illustration of the interrelation of disease in man, animals and plants, I may remark that our knowledge of the viruses began with a plant disease—mosaic of tobacco—in which they were first discovered in 1892–93; the next virus disease discovered was foot and mouth disease of cattle, which occurred in 1897; and the first human virus disease to be recognized was yellow fever in 1901. Now, we have learned that infantile paralysis, or poliomyelitis, belongs in this category.

The viruses, as they occur in nature, are revealed to us only as they produce disease. That is, we know them not as such, but through their effects. As this proposition is first stated, it is rather disquieting and one may wonder whether such indirect knowledge is in the true sense knowledge at all. A similar and no longer disquieting case is that of the atom and the still smaller electron, which also are known only through their effects. No one imagines the atom to be a living thing, but pathologists are deeply concerned with the question of whether the invisible viruses are or are not living entities. Can all the phenomena of life—assimilation, respiration, multiplication—go on in such minute particles of matter? The question is still unsettled; but what has recently been found is that some viruses are definite chemicals; for example, the virus of tobacco mosaic disease which has been obtained in crystal form. And as the solution of one such major problem always raises others, we are now confronted with the question of the possibility of inanimate matter multiplying enormously in the body.

[6] There must be persons in this audience who can recall as I can the periodic outbreaks of yellow fever in our southern states. The demonstration of the mosquito carriage of the disease by Major Reed and his small group of volunteers by experiments made on themselves has put an end to those disasters. A quarter of a century later Adrian Stokes laid down his life in Nigeria, Africa, in showing that the monkey can be given yellow fever. Since then knowledge of the disease has grown rapidly. One of the great practical gains has been a method of protective inoculation. The perils of a journey to epidemic places in South America and Africa have now been removed and yellow fever is to be classed among the preventable diseases.

An infinitesimal amount of crystalline mosaic virus introduced into a tobacco plant increases greatly. But we may well leave that problem for the present, feeling that its solution will come in good time.

The viruses differ among themselves in size as measured by physical-chemical methods, and in stability—some are so delicate that they do not withstand chemical reagents. But the invention of the vacuum ultracentrifuge is making the investigation of the nature of these labile viruses possible. These centrifuges are capable of amazingly high speeds which yield a pull as great as 300,000 times gravity. Hence excessively minute bodies can now be aggregated so as to be brought under physical biological study. And by means of the x-ray photographic device, even their structure may be defined.[7]

I seem to have wandered far afield in closing this sketch of the medicine of America of the past half-century. In reality I have not strayed at all. These new discoveries are American in origin and they relate directly to medicine. Moreover, they illustrate in a particularly enlightening manner the interdependence of the physical and the medical sciences. I have already said that there is nothing peculiar about medical science, that it is only biology, physics and chemistry applied *to a particular end*. In these final examples there is nothing but physics and chemistry used to elucidate problems in comparative pathology—that is, the pathology of all living things. And pathology is merely the basic subject of how disease comes about—how it is initiated in the first instance, through what changes in structure function is impaired, and then finally through what retrogressive alterations health is restored. Just as anatomy and physiology together show us the relation of structure and functions in the normal body, pathological anatomy and pathological physiology or experimental medicine together show us the related altered structure and function in the diseased body. As these subjects come to be better understood, the diagnosis and treatment as well as the prevention of disease will become more scientific and successful.

We have followed some of the developments which in the space of half a century have raised American medicine from a low state to a leading position in world medicine. There is nothing accidental in this great change. What we are witnessing is merely the continuation of the movement westward which has marked the diffusion of knowledge since the revival of learning in the fifteenth century.

"We are like dwarfs," said Bernard of Chartres in the twelfth century, "seated on the shoulders of giants. We see more things than the ancients and things more distant; but it is *neither due to the sharpness of our* sight nor the greatness of our stature; it is simply because they have lent us their own."

[7] Method has always had a determining influence on experimental science. With every important advance in methods, new discoveries have been made or old ones perfected. Modern medicine owes a great debt to the physical sciences for the new and improved methods they have introduced. But it has the merit of having advanced itself by the discovery of methods applicable in the clinic and in the laboratory through which the diagnosis and treatment of disease have been enhanced.

SCIENTIFIC EVENTS

THE POLAR EXPEDITION OF THE U.S.S.R.

THE daily press reports that a Soviet airplane made a successful landing at the North Pole on May 21, and established a permanent weather and scientific station as the first step in the plan for regular air communication between Russia and America by way of the polar region.

The expedition is in charge of Dr. Otto J. Schmidt, professor of mathematics at the University of Moscow, director of the Soviet Arctic Institute and head of the Northern Sea Route Administration. The flight was made from Rudolph Island, about 82 degrees north and 60 east (or about 560 miles from the Pole). A. V. Vodopyanov was pilot of the plane.

The radio message sent to the U.S.S.R. government at Moscow follows:

We send you, through the Dickson Island radio station, greetings from the North Pole.

Aboard the Soviet plane, *USSR N–170*, we crossed the pole at 11: 10 Friday morning. In order to obtain the best results we passed a little beyond the pole seeking a landing field.

We first crossed the pole at 1,750 meters and then came down to 250 meters through the clouds, seeking a place to land. At 11: 35 A.M. we landed.

We are sorry to report that difficulty with the radio apparatus delayed our reports to you.

We are about twenty kilometers beyond the pole and a little to the west of the Rudolf Island meridian. We are on an ice floe, but it is possible to bring other planes here to establish a polar station.

Our regards to the government and the party.

Four men plan to remain at the station for about a year. They are Ivan Papanin, who will be in charge; Ernest Krenkel, radio operator; Pyotr Shirsov, hydrobiologist, and Eugene Federov, magnetologist. They will use a carefully planned folding house about 12 feet long by 9 feet wide, and 6½ feet high, which has been elaborately insulated. It weighs only 353 pounds and, in case the ice shows signs of breaking, it can be moved to a new site without dismantling.

SCIENTIFIC EXHIBITS AT THE ROYAL SOCIETY CONVERSAZIONE

The British Medical Journal gives an account of the scientific exhibits shown at Burlington House at the conversazione of the Royal Society on May 4. It states that among historical exhibits were the royal charters of the society, with the charter-book containing the signatures of the founder, patrons and fellows from 1662 to the present day. There were also shown original manuscripts and manuscript letters of early fellows, including Boyle, Hooke, Leeuwenhoek, Leibnitz, Malpighi and Newton. Another exhibit consisted of diplomas and other original documents of William Hyde Wollaston, a recent gift to the society from the Wollaston family. There was also exhibited an unrecorded watercolor portrait of John Dalton; this was shown under the zograscope, a contemporary optical instrument used for domestic entertainment in the eighteenth century. A number of exhibits related to investigations on plants, especially on virus infections.

Imperial Chemical Industries has been experimenting on plant hormones. Substances have been isolated from plants and shown to possess growth-promoting properties, and some of the effects of heteroauxin on plant tissues were demonstrated. There were cameras for television, microscopes for ultra-violet light, and an instrument for the photographic recording of transient phenomena, such as lightning surges, with which records could be obtained of phenomena lasting only one or two millionths of a second.

Professor H. H. Woollard exhibited x-ray films illustrating the lymphatics of the human body after injection with thorotrast and barium. Some of this work with thorotrast is described in the recent annual report of the British Empire Cancer Campaign. Another demonstration was of a subjective photometer by Dr. W. D. Wright. This instrument has been used to measure the adaptation functions of normal eyes, and it is hoped to extend the measurements to test the effect of various pathological conditions on the adaptation process.

An unusually large number of exhibits of biological and zoological interest were on view. These included an exhibit showing tails of birds of paradise, bringing out their variations, and a collection of spiny mammals—echidnas of the Australian region and the more familiar hedgehogs and porcupines. Both were from the Natural History Museum.

During the evening a short lecture was given by Professor Andrade on events and personalities in the history of the Royal Society and the vicissitudes of its fellowship in days gone by.

THE CHESAPEAKE BIOLOGICAL LABORATORY

THE Chesapeake Biological Laboratory is situated on the picturesque and interesting Solomons Island at the mouth of the Patuxent River, facing the celebrated Drum Point Harbor, in the very center of the Chesapeake Bay region. It is about 90 miles from the ocean and about the same distance from the fresh waters at the head of the bay. Some ten miles distant across the bay lie the shallow and placid tidewater estuaries of the Eastern Shore, famous for their extensive blue-crab and oyster fisheries. Located in this section is the laboratory's one-thousand acre Aquicultural Experiment Farm. Fresh-water streams flowing into the Patuxent, as well as ponds, offer ample opportunity for the study of fresh-water biology, and near-by along the bay are outcroppings of rich Calvertian fossil beds.

The laboratory first began to take form in 1919, and the present building was built in 1931. A new dormitory has just been completed. On a recently completed 760-foot pier there is a tidal station operated in cooperation with the United States Coast and Geodetic Survey. A large boat, a small power boat and small boats and canoes are at the service of the laboratory. The laboratory is a cooperative organization, the cooperating institutions being the Carnegie Institution of Washington, Goucher College, Johns Hopkins University, the University of Maryland, Washington College, Western Maryland College and the Maryland Conservation Department. It is open from June to August, inclusive, class work beginning on June 23 and ending on August 4.

The laboratory maintains a staff of three on full time, the cooperating institutions supplying the remainder of the personnel and paying their expenses. The problems of special interest to the members of the staff during the present season are: the hydrography of the Patuxent area (Dr. C. L. Newcombe, University of Maryland); the biology of the striped bass and shad (Dr. V. D. Vladykov, Maryland Conservation Department); the algae of the Solomons Island region (Dr. H. C. Bold, Vanderbilt University, working under the auspices of Western Maryland College); the migration and distribution of the blue-crab (Dr. R. V. Truitt, University of Maryland); the diatoms of the Atlantic coast (Mr. Paul S. Conger, Carnegie Institution of Washington); studies on the life history of the blue-crab (Mr. Roy Robertson, Western Maryland College); the biology of *Cliona celata* (Dr. M. C. Old, Ursinus College, working under the auspices of Johns Hopkins University); methods for water analysis (Dr. R. P. Cowles and Dr. Bramble, Johns Hopkins University); strobilization and polymorphism in *Dactylometra quinquecirrha* (Mr. Littleford, University of Maryland); food analyses of the striped bass (Mr. Edgar Hollis, Western Maryland College); physical, chemical and biological fitness of Gun Powder Falls watershed as a brook trout environment (Mr. Fred Seiling, Univer-

sity of Maryland); age and rate of growth of the striped bass in Chesapeake Bay (Mr. David Wallace, Maryland Conservation Department); and certain physico-chemical toleration points in oyster germ cells and larvae (Drs. R. V. Truitt and C. L. Newcombe, University of Maryland).

In addition to work on these special problems a biological survey of the Solomons Island region is being conducted at the laboratory. This survey is comprehensive in outline and is planned as a project of several years' duration. All members of the staff assist, as their time permits, in the work of collecting, preserving and classifying the biological material. This offers an excellent opportunity for advanced students, instructors and specialists in biological subjects to engage in field work and make observations on living things in their natural surroundings.

For the coming season courses are offered in the various significant modifications, structure, habits and classification of the invertebrates; algae; economic zoology; diatoms; ichthyology; experimental zoology, especially the influence of temperature, salinity and certain other factors on behavior, growth and reproduction, special attention being paid to mollusks, crustaceans, polychaetes and coelenterates; and in various biological problems.

The director of the Chesapeake Biological Laboratory is Professor R. V. Truitt, of the University of Maryland, College Park, Md.

AUSTIN H. CLARK

SYMPOSIUM AT THE DENVER MEETING ON THE CONTROL OF DRIFTING SOILS

THE general symposium arranged for the Denver meeting under joint auspices of the American Association and the Ecological Society of America deals with the important problem of "The Scientific Aspects of the Control of Drifting Soils." The program last year on the scientific aspects of flood control was very successful and this year's topic follows naturally in a region where wind erosion is of outstanding importance. Three speakers have been invited to discuss the geological, the biological and the present human phases of the question.

"The Geological Aspects of the Drifting of Soils" will be the topic of the first paper by Dr. M. M. Leighton, chief of the Illinois State Geological Survey. He will consider the nature, importance and examples of the geological factors involved and the cardinal principles to be learned from the geological record.

"Climatic Cycles and Human Populations" is the subject announced by Dr. F. E. Clements, of the Division of Plant Biology of the Carnegie Institution of Washington. He will discuss shortgrass and climate, plant cover in relation to erosion and flood and cooperation as an ecological process.

The final paper by H. H. Bennett, chief of the U. S. Soil Conservation Service, is entitled "Emergency and Permanent Scientific Control of Wind Erosion." He plans to discuss the precise nature of the human problem and the factors involved in wind erosion with especial reference to emergency control *vs.* permanent control.

Each of the papers will be illustrated by demonstrations, lantern slides or other special means.

The symposium will be held at two o'clock on Thursday afternoon, June 24, in the lecture hall of the Trinity Building near the association headquarters. The general plan of the program and arrangements with speakers have been made primarily by Dr. H. de Forest, representing the Ecological Society of America. The sections of the association and affiliated societies meeting in Denver have arranged their special programs so far as possible to avoid conflicts with the symposium in order to permit all members to attend this discussion of a problem of great social importance at the present time.

HENRY B. WARD

AWARDS OF THE LALOR FOUNDATION

THE Lalor Foundation, organized in 1935 for the advancement of scientific research, has issued a statement announcing the recipients of its awards for the academic year 1937–38. These are the first grants made by the foundation and comprise four fellowship awards of $2,500 each for research in chemistry. Seventy-eight applications were received from 70 men and 8 women. They were reviewed by an advisory committee composed of the following scientific men:

Dr. Roger Adams, chairman of the department of chemistry, University of Illinois.
Dr. Katharine Blunt, president of the Connecticut College for Women.
Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry*.
Dr. Henry G. Knight, chief of the Bureau of Chemistry and Soils, U. S. Department of Agriculture.
Dr. Charles A. Kraus, chairman of the department of chemistry, Brown University.
Dr. Arthur B. Lamb, professor of chemistry, Harvard University.

The appointments are as follows:

James English, Jr., Ph.D., Yale University, research assistant at the California Institute of Technology, to continue research at the institute on the isolation and constitution of certain hormones promoting plant growth.

Leland John Haworth, Ph.D., University of Wisconsin, instructor of physics at the university, to work in the Research Laboratory of Physical Chemistry at the Massachusetts Institute of Technology on the magnetic properties of materials at very low temperatures.

Philip Albert Leighton, Ph.D., Harvard University, asso-

ciate professor of physical chemistry at Stanford University, on leave of absence to conduct research in England and at Harvard University on the properties of free atoms and radicals produced during chemical and photochemical reactions.

Earl Albert Long, Ph.D., Ohio State University, instructor in chemistry at the University of California, to conduct research at the University of California on the properties of radioactive sodium and radioactive phosphorus.

Two additional candidates were recommended for awards, namely, Dr. Eric G. Ball, associate professor of physiological chemistry at the Johns Hopkins University, and Dr. Nelson R. Trenner, instructor in chemistry at Princeton University. Dr. Ball was simultaneously appointed to a fellowship from the John Simon Guggenheim Foundation, which he has accepted. Dr. Trenner has withdrawn in order to accept a permanent research appointment.

The announcement of the awards was made by Dr. C. Lalor Burdick, secretary of the foundation. The other officers are: Dr. Charles Lee Reese, *president;* Mrs. Anna Lalor Burdick, *vice-president,* and Elwyn Evans, *treasurer.*

RECENT DEATHS

DR. HERBERT ELLSWORTH SLAUGHT, since 1931 emeritus professor of mathematics at the University of Chicago, died on May 21 at the age of seventy-six years.

DR. JOSEPH A. CULLER, professor emeritus of physics at Miami University, Ohio, died on May 16 at the age of seventy-nine years.

DR. JOHN MOORE READE, since 1908 professor of botany and from 1919 to 1926 director of the biological laboratories at the University of Georgia, died on May 8 at the age of sixty-one years.

DR. WILLARD L. WACHTER, Charles McIntyre professor of biology at Lafayette College, died on May 18 at the age of thirty-nine years.

ALEXANDER HOWARD MCCONNELL, founder and chairman of the board of directors of the Central Scientific Company, died on May 4, in his sixty-first year.

DR. HARRY G. TIMBRES, of Edmonton, Canada, died on May 12 of typhus contracted while carrying out antimalarial experiments for the Tropical Institute of Moscow.

DR. ARTHUR HARRY CHURCH, formerly reader in botany at the University of Oxford, died on April 24, at the age of seventy-two years.

SCIENTIFIC NOTES AND NEWS

DR. JOHN J. ABEL, emeritus professor of pharmacology at the Johns Hopkins University, celebrated his eightieth birthday on May 19 at a banquet given in the Welch Medical Library, which was attended by colleagues and former students. At its conclusion he was presented with a scroll bearing the names and greetings of those present. Telegrams from friends from all parts of the country were read.

A PLAQUE of Dr. Henry H. Donaldson, of the Wistar Institute of Anatomy, sculptured by Dr. R. Tait McKenzie, was presented to the Lenape Club of Philadelphia by Dr. McKenzie on the occasion of the eightieth birthday of Dr. Donaldson on May 12, and commemorating the twentieth anniversary of his presidency of the club.

DR. HARVEY CUSHING, since 1933 Sterling professor of neurology at the Medical School of Yale University, previously Moseley professor at the Harvard Medical School and surgeon-in-chief of the Peter Bent Brigham Hospital, will retire at the close of the academic year and will become professor emeritus.

SIR ANDREW MACPHAIL will retire at the end of the present summer term from the chair of medical history in McGill University, which he has held for over thirty years.

THE Daniel Guggenheim Medal for 1937, presented annually "in recognition of meritorious achievements in the furtherance of aeronautics," has been awarded to Dr. Hugo Eckener. The presentation will be made at a dinner to be given in his honor in New York on December 17, the thirty-fourth anniversary of the first flight of the Wright brothers. The medal is awarded to Dr. Eckener for "notable contributions to transoceanic air transport and to international cooperation in aeronautics."

THE Walker Prize of $100 of the Boston Society of Natural History has been awarded to Dr. V. C. Wynne-Edwards, assistant professor in the department of zoology of McGill University, for his work entitled "Isolated Arctic-Alpine Flora of Eastern North America." A second prize of $60 has been awarded to William D. Gray, of the University of Pennsylvania, for a paper on "Myxomycete Studies: The Influence of Light on the Fruiting of *Physarum polycephalum.*"

THE Royal Anthropological Institute of Great Britain and Ireland has awarded the Wellcome Gold Medal for anthropological research for 1936 to Dr. Charles Kingsley Meek for an essay entitled "Law and Authority in a Nigerian Tribe. A Study in Indirect Rule." The Rivers Memorial Medal for anthropological work in the field for 1937 has been awarded

by the institute to Dr. Edward Evan Evans-Pritchard for his field work in the Anglo-Egyptian Sudan and Kenya during the last ten years.

THE Founder's Medal of the Royal Geographical Society of London has been awarded to Colonel C. G. Lewis for his surveys on the Miri Mission, 1911–12, in Iraq and Syria, 1918–19, and on the Afghan and Turco-Iraq Boundary Commissions; for the air survey of the Irrawaddy Delta, 1924; and for his promotion and encouragement of the exploration and survey of the Himalaya.

THE degree of doctor of laws will be conferred at the commencement of Villanova College on June 3 on Dr. Charles H. Mayo and Dr. William J. Mayo, of the Mayo Foundation, Rochester, Minn.

HONORARY degrees conferred at a special convocation of the University of Manitoba in connection with its diamond jubilee celebrations included the doctorate of laws on Vilhjalmur Stefansson, the Arctic explorer.

PROFESSOR JOSEPH GRINNELL, director of the Museum of Vertebrate Zoology of the University of California, was elected president of the American Society of Mammalogists at the recent meeting held in Washington, D. C.

DR. SYDNEY CUNNINGHAM, of the School of Medicine of Vanderbilt University, has been appointed dean of the Albany Medical College, Albany, N. Y. He will succeed Dr. Thomas Ordway, who has resigned after serving for twenty-two years.

DR. HARRY STOLL MUSTARD and Dr. William Smith Tillett, both of the Johns Hopkins University, have been appointed members of the faculty of the College of Medicine of New York University. Dr. Mustard has been appointed Hermann Biggs professor of preventive medicine and director of the laboratories of preventive medicine to fill the chair left vacant by the retirement of Professor William Hallock Park. He also becomes director of the new District Health Center. Dr. Tillett will become professor of bacteriology and director of the bacteriological laboratories.

DR. KARL S. LASHLEY, professor of psychology at Harvard University, has been appointed research professor of neuropsychology and has been relieved of responsibility for routine instruction. He will offer a graduate seminary and direct research in neuropsychology.

DR. G. ALBIN MATSON, associate professor of bacteriology at the Montana State University, has been appointed to an assistant professorship in the department of bacteriology and pathology of the School of Medicine of the University of Utah.

DR. CLIFFORD C. GREGG has been appointed director of the Field Museum, Chicago. Since the death of Stephen C. Simms in January, who had held the post of director since 1928, Mr. Gregg has been in charge of the administration of the museum under a temporary appointment as acting director. He is the fourth director to hold office since the museum was founded in 1893. His predecessors have been the late Stephen C. Simms, the late David C. Davies and the late Frederick J. V. Skiff, who was the first director. A member of the staff since 1926, Mr. Gregg served as assistant to the director under both Mr. Simms and Mr. Davies.

AT a recent meeting of the executive committee of the Long Island Biological Association it was voted to appoint Dr. Eric Ponder, who has for the past year been interim director, as director of the Biological Laboratory, Cold Spring Harbor, Long Island, N. Y.

DR. M. S. NAVASHIN, of the Institute of Genetics, Academy of Sciences, U.S.S.R., has resigned the directorship of the Botanic Garden of the University of Moscow. He will henceforth devote all his time to cytogenetic research.

THE Committee on Scientific Research of the American Medical Association has made grants as follows: to Dr. Ira A. Manville, of the School of Medicine of the University of Oregon, for an extension to connective tissues of his work on the mucous epithelium; to Dr. G. Albin Matson, associate professor of bacteriology at the Montana State University, for a study of the antigenic properties of certain chemical substances; to Dr. James B. Hamilton, of Albany Medical College, for a study of the effect of male hormone substance on testicular descent, and to Dr. George M. Curtis, of the Ohio State University, for the continuation of his work on calcium and iodine metabolism as related to thyroid disease.

DR. ALEXIS CARREL, of the Rockefeller Institute for Medical Research, has sailed for Europe to pass the summer in Paris and Brussels, where he plans to continue research.

DR. GUSTAV EGLOFF, director of research of the Universal Oil Products Company, Chicago, will sail on June 2 for England. He is a delegate from the American Petroleum Institute to the Second World Petroleum Congress, to be held in Paris from June 14 to 19. He plans to spend a week in England lecturing before going to Paris to attend the congress. He will also spend some time in Holland, Belgium, Germany, Czechoslovakia and Austria, visiting refineries and oil fields in addition to giving lectures.

DR. WILLIAM BOWIE, formerly chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, gave on May 14 an address before the Rittenhouse

Astronomical Society of Philadelphia entitled "Contributions of Geodesy to Our Knowledge of the Earth."

THE twelfth Edgar Marburg Lecture will be delivered on June 30 at the fortieth annual meeting in New York City of the American Society for Testing Materials by Dr. T. Smith Taylor, professor of physics in Washington and Jefferson College. The subject of the lecture will be "Plastics: Some Applications of Different Classes, Methods of Testing."

THE second Leo Loeb Lecture, under the annual lectureship established by the Mu Chapter of Phi Beta Pi, medical fraternity, was delivered on May 14 by Dr. Anton J. Carlson, professor of physiology at the University of Chicago, on "Problems in the Control of the Endocrine Glands."

DR. EDWARD KASNER, Adrain professor of mathematics at Columbia University, recently addressed a joint meeting of Phi Beta Kappa and Sigma Xi at Rutgers University on "Imagination and Conception in Mathematics."

AT the twentieth annual meeting of the American Society of Ichthyologists and Herpetologists, held in Washington, D. C., from May 4 to 8, the following officers were elected: John T. Nichols and Leonhard Stejneger, *Honorary Presidents;* William K. Gregory, *President;* L. M. Klauber, Leonard P. Schultz and Hobart M. Smith, *Vice-presidents;* M. Graham Netting, *Secretary;* Arthur W. Henn, *Treasurer;* Helen T. Gaige, *Editor-in-Chief* of *Copeia;* Lionel A. Walford, *Ichthyological Editor;* Karl P. Schmidt, *Herpetological Editor.* Four honorary members were elected: for 1936, Professor David M. S. Watson, University College, London, and Professor Franz Werner, University of Vienna; for 1937, Dr. Leo S. Berg, Academy of Sciences, Leningrad, and Dr. W. Wolterstorff, Museum für Natur- und Heimatkunde, Magdeburg. Dr. G. A. Boulenger is the only previously elected honorary foreign member.

AT a meeting of the Ohio State University Chapter of Sigma Xi forty-nine members and forty-one associate members were elected. In the evening following the spring banquet of the society, Professor Raymond Pearl, of the Johns Hopkins University, spoke on "The Relation of Population to Fertility." Officers of the Ohio State chapter are Professor Eugene Van Cleef, *president;* Professor J. H. Gourley, *vice-president,* and Professor Fred A. Hitchcock, *secretary.*

THE Michigan Chapter of the Society of the Sigma Xi held its annual initiation banquet on the evening of May 5. Professor Jesse Ormondroyd, of the department of engineering and mechanics of the University of Michigan, delivered the address for the occasion on "The Two Hundred Inch Telescope Mounting." Five faculty members, three alumni and eighteen graduate students were elected to full membership. Sixty-six graduate students and twenty-three undergraduates were elected as associates. In addition, one faculty member and twenty graduate students were advanced from associate to full membership.

THE fourth annual initiation of the Massachusetts Institute of Technology Chapter of the Society of Sigma Xi was held on May 20. Officers elected for the next year were Professor Arthur C. Hardy, *president;* Professor Walter C. Voss, *vice-president;* Professor Bernard E. Proctor, *treasurer;* Professor John B. Wilbur, *secretary,* and Professor Hoyt C. Hottel, *elector.* The initiates elected included twenty-four members and twenty-two associates. Following the ceremonies, at which Dr. John W. M. Bunker, retiring president, presided, the initiates were guests at a dinner at Walker Memorial at which Dr. Homer W. Smith, professor of physiology of the College of Medicine of New York University, spoke on "The Lung-Fish, an Amazing Anomaly of Nature."

THE sixty-second annual meeting of the American Forestry Association, planned as a joint meeting with the Ohio Forestry Association, will be held at Cincinnati, Ohio, from May 31 to June 3. The chief subject to be considered will be water conservation and flood control. There will be a day-boat trip on the Ohio River, giving a first-hand view of after-flood scenes and river works designed to deal with flood waters in the main river; and a day's motor tour of the Muskingum Watershed Conservancy District, where source control and conservation of water is being undertaken. The Muskingum Conservancy represents the first and only large scale cooperative effort on the part of the Federal Government, the state and local communities to deal with the flood problem in a given drainage basin.

A SYMPOSIUM on the viruses was held in San Francisco on May 6 by the Pasteur Society of Central California. Three papers were presented: "The Cultivation and Handling of Viruses," by Alfred Lazarus, Edith Claypole research fellow, Hooper Foundation, University of California; "Recent Developments in the Study of Plant Viruses," by Dr. T. E. Rawlins, associate professor of plant pathology and associate plant pathologist in the Experiment Station, College of Agriculture, University of California; and "Poliomyelitis and its Problem of Control," by Dr. E. W. Schultz, professor of bacteriology and experimental pathology, Stanford University. The following officers were elected for the coming year: *President,* Dr. J. C. Geiger, director of public health of the City and County of San Francisco; *Vice-president,* Dr. Charles E. Smith, Stanford University Medical School; *Secre-*

tary-Treasurer, Dr. Herbert G. Johnstone, department of bacteriology, University of California Medical School; *Councillors,* Dr. Ethel McNeil, department of zoology, University of California, and Dr. Harry E. Foster, medical director of the Cutter Laboratories, Berkeley. The membership of the society at the close of this year is 320.

THE second annual meeting of the Oregon Psychological Association was held at Reed College on May 1. A symposium was held on "The Measurement and Evaluation of Personality," and individual research reports were presented. Professor William Griffith, of Reed College, was chairman and delivered an evening address entitled, "The House of Magic." Dr. L. F. Beck, of the University of Oregon, was elected secretary. The Oregon Normal School was selected as the place of meeting for next year.

THE Botanical Society of America and the American Society of Plant Taxonomists will hold two joint summer field meetings in August. The first of these meetings will be held at Acadia University, Wolfville, N. S., from August 18 to 21; the program for this meeting is being arranged by the officers of the Botanical Society of America. The second meeting will be held at the Biological Station of the University of Michigan at Douglas Lake, from August 24 to 27. Officers of the American Society of Plant Taxonomists are arranging the program for the Douglas Lake meeting.

DURING the summer session of the College of Arts and Science of the University of Rochester, two summer courses in photography will be given under the joint auspices of the Institute of Applied Optics of the university and the Eastman Kodak Research Laboratory. They will be under the immediate supervision of Dr. T. R. Wilkins and Dr. Walter Clark, and will be similar in nature to those given in the regular curriculum of the Institute of Optics. The elementary course will run from June 22 to July 13 and the advanced course from July 5 to July 23. The lectures in the latter course will be given by Dr. C. E. Kenneth Mees, Dr. L. A. Jones and Dr. W. Clark, of the Kodak Research Laboratories. In addition, from July 5 to July 9, there will be a course on "Photographic Photometry and Spectrophotometry," conducted by Dr. Brian O'Brien; and from July 12 to July 16 Dr. T. R. Wilkins will lecture on "The Photographic Emulsion as a Tool in Atomic Nuclear Research." During the courses trips of inspection have been planned to the Kodak Park Laboratories and the Kodak Camera Works.

THE John and Mary R. Markle Foundation of New York City has recently appropriated to the National Research Council the sum of $100,000 to be available over a three-year period for the support of research in endocrinology. This fund will be administered by a committee of the Division of Medical Sciences of the council to be appointed later this spring and will be allotted in grants for the support of approved programs of research in this field to be conducted in institutions which may wish to collaborate in these investigations.

DISCUSSION

THE FLORA OF CALIFORNIA

WITHOUT attempting an adequate review, I venture to call attention to some of the features of W. L. Jepson's "Flora of California," Vol. 2, Capparidaceae to Cornaceae, a work of 684 pages published at the University of California last year. It is one of the most interesting and stimulating floras I have seen, and is especially to be valued for its full discussions of debatable points and the historical data often given with the more important species. We may envy the Californian students of flowering plants, who are now so well provided with information concerning the very unique flora of the Pacific Coast region. It must not be thought, however, that discoveries are no longer possible. There is very much to be found out, and such works as Jepson's should stimulate zeal for investigation, by providing a basis for the judgment of such observations as may be made.

One feature in Jepson's work which I greatly regret is his custom (following the old "Kew rule") of citing as the authority for a species or variety the writer who proposed the combination used. Thus the common water-cress, named *Sisymbrium nasturtium-aquaticum* by Linnaeus in 1753, appears as *Radicula nasturtium-aquaticum* Britten and Rendle, 1907. Such usage hides the true history of the plant, and prevents the recognition of the original describer. The usual custom of botanists to-day is to cite the original author and also the author of the combination, thus: (Linnaeus) Britten and Rendle. In zoology, however, we use the double citation only in formal monographs, if at all, and I have never been able to see that we lost anything of value by the omission of the author of the binomial or trinomial accepted, when that is based on an earlier name. It is perhaps ungracious to say it, but one can not avoid a suspicion that sometimes the double citation or the single citation, as given by Jepson, acts as a stimulus to the formation of new combinations.

Another quite different matter has to do with the

recognition of genera. It is very inconvenient to students to find marked differences in the standard works of Jepson, Munz and Abrams, all dealing with the west coast flora. It should be possible to form a committee to reach a common agreement on these matters. There is no fixed rule for the recognition of a genus, and in many cases possible alternatives seem about equally permissible. Take, for instance, the genera of Cruciferae, and examine Jepson's key for their recognition. We find, for example:

Flowers yellow, or often white in Nos. 4 and 5 (four genera)
Flowers white or whitish (rarely yellowish) to purple or purplish (four genera)

or again:

Seeds in 1 row in each cell (except 2 species in No. 5 and several in No. 16 (nine genera)
Seeds 2 rows in each cell (2 genera)

These definitions well illustrate the difficulty of sharply limiting the genera, yet nearly all the genera cited are readily recognizable in the field by their "facies." Munz recognizes *Descurainia* (often called *Sophia*), which differs from *Sisymbrium* by the forked hairs, and by its characteristic appearance. Jepson merges it in *Sisymbrium*, which then becomes an assemblage of very different looking plants. I think it is a good genus, but that is more or less a matter of opinion.

Another obvious criticism has to do with the numerous "varieties" proposed or cited. Apparently the intention usually is to recognize such units as we term subspecies in zoology, but there is no doubt a mixture of forms due to the direct influence of the environment. The intergradation which leads botanists to reduce plants to varietal rank may be due to crossing. Botanists must not be blamed for this inexact treatment, since they usually lack the necessary information for more correct judgments. But each "variety" may be taken as a sort of challenge to the coming generation of workers to determine its real biological significance.

We miss, in all these botanical works, any reference to the animal life associated with the plants. It is singular that botanists rarely take the least interest in the insects which bring about the fertilization of the flowers, those which devour the various parts of the plant, or form galls. Every species of plant is a stage on which a drama of animal life is enacted, and some day, we may hope, this will be recognized and the facts properly described and illustrated. Here is a vast field for study, rich in opportunities for discovery.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

SPARGANA IN NATRIX

IN SCIENCE for January 29, Dr. L. J. Thomas reports the finding of spargana (larvae of the cestode genus Diphyllobothrium) in a Natrix taken near Ithaca, N. Y. These spargana had been collected by Mr. Elmer Brown, of Cornell University. The first instance of spargana in water snakes in this country to come to my attention was a case related to me verbally in December, 1936, by Dr. George R. La Rue, of the University of Michigan. In this instance the spargana were found in a water snake taken in the Okefinokee Swamp, Georgia. In neither of the above cases were the spargana fed to suitable definitive hosts to determine what species was represented.

I wish to report here the finding of spargana in Natrix from Florida. In February, 1937, two lots of Natrix, one from Sarasota, the other from Silver Springs, Florida, were examined for spargana, and found to be about 90 per cent. infected. The number per snake varied from one to seven. These spargana were in all respects similar to the larvae of *Diphyllobothrium mansonoides* Mueller, the only *Diphyllobothrium* known from this country which might be presumed to infect Natrix in the larval stage. The larvae in this case have been fed to numerous suitable definitive hosts, and it should therefore be possible shortly to determine the exact identity of this parasite.

I have previously reported, in a preliminary note on the life history of *D. mansonoides*, the failure to infect snakes with the sparganum of this parasite. However, in these experiments garter snakes were used instead of Natrix, it being supposed that the genus of snakes would make little difference in the outcome of experiments on a larva which has such a wide diversity of hosts as the sparganum of *D. mansonoides*. Probably this supposition was in error.

A very limited number of Natrix from the vicinity of Syracuse were examined for spargana during the summer of 1936, but were reported negative. In this connection it is of interest to note that Mr. Elmer Brown, finder of the spargana reported by Thomas, states in a personal letter: "Frankly, I am not optimistic over the prospect of the forms being found again very readily. I have dissected a good many snakes from this region, but I am reasonably certain that the specimen of last spring was the first I have opened which carried this genus." This is in conflict with the idea that this sparganum is the larva of *D. mansonoides*, since this parasite, in the adult stage, occurs very commonly in cats in this region, and therefore its larva should occur commonly in all potential hosts.

With experiments and further work now under way, it should be possible very shortly to clear up this puzzling and very interesting question.

NOTE: Since this article was first sent in to SCIENCE, the adult cestodes have been recovered from experimentally infected cats, and found to be of two different types, the one morphologically identical with *D. mansonoides*, the other resembling *D. mansoni* in general, but apparently differing from this species in certain important respects. In any case this is the first record of this second form for this country. It is clear therefore that Florida water snakes are infected with two different species of spargana. Further work on these forms will be reported elsewhere.

JUSTUS F. MUELLER
N. Y. STATE COLLEGE OF FORESTRY
SYRACUSE, N. Y.

PHOTOMICROGRAPHS AND MICROPHOTOGRAPHS

IN the March 5 issue of SCIENCE Professor Luyten made some interesting comments on scientific nomenclature, refers to the term "photomicrograph" as a "horrible hybrid" and expresses his preference for the term "microphotograph," which he recommends as the proper word. This was particularly interesting to me because at about 1912 I wrote numerous abstracts of German papers on the subject of "Metallography" and in these abstracts I repeatedly used the word "microphotograph," only to have the editor of *Chemical Abstracts* invariably change the word to "photomicrograph." At that time, I was rather peeved because I preferred the sound of the word that I used and it was a more literal translation of the German text which I was following. The learned editor of *Chemical Abstracts* carefully pointed out to me that the reader might imagine the word "microphotograph" to signify a very small photograph, whereas I meant the photograph of something that the naked eye could not perceive because the camera was placed over a microscope and the photograph, which was of perfectly normal size, represented a magnification of perhaps 500 diameters.

I have on my desk a 1937 edition of Webster's Collegiate Dictionary, and the term "microphotograph" and "photomicrograph" are both defined in the above sense, although under the former definition a secondary meaning is given as follows: "loosely a photomicrograph." The term "horrible hybrid" is usually applied to words derived from two languages. Thus the term "monovalent," which is often carelessly used by chemists, is frowned upon and it is considered better to use the term "univalent" because "valence" is derived from a Latin word and *uni* expresses in Latin the same idea that *mono* does in Greek. Since the three parts of "photomicrograph" are all derived from Greek words, the word can hardly be called a "horrible hybrid."

If Professor Luyten's communication had been written in 1912, I know I should have hailed it with joy, but I have learned a lot since then and have come to the conclusion that the editor who compelled me to use the term "photomicrograph" twenty-five years ago was wiser than I and did me a service in correcting my writings.

WILLIAM T. HALL
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A MISLEADING ARTICLE IN THE AMERICAN MAGAZINE

IN the May, 1937, issue of *The American Magazine* appeared an article under the name of H. H. Nininger, curator of meteorites in the Colorado Museum of Natural History. This article, which was entitled "It Pays to Keep Your Eyes Open," was not written by Mr. Nininger, as the by-line implies, but by the writer of this statement. Mr. Nininger was responsible for only the portion of the article which deals with meteorites and fossils. The portion dealing with plants and Indian relics was appended by me, solely on my own responsibility.

The original version of the article, which was the only version approved by Mr. Nininger, contained almost no reference to plants or Indian relics. These references were added, without his knowledge, when the editor of *The American* requested me to "fatten" the article. Furthermore, the article was intended to appear "As told to Frank Clay Cross," not as Mr. Nininger's own work.

I have long enjoyed an intimate friendship with Mr. Nininger, and the fact that this article has caused him considerable embarrassment is a matter of great regret to me. If any reader has drawn the inference from it that he is, in any sense, interested in the commercialization of science, that inference is entirely unjustified. The whole blame must rest on me.

This statement is written entirely on my own volition to correct an unfortunate error, in so far as it is possible for me to correct it.

FRANK CLAY CROSS

QUOTATIONS

THE SOVIET POLAR EXPEDITION

THE landing of a Soviet plane at the North Pole and the setting up of the first permanent North Pole weather and scientific station is an achievement that is receiving the wide and enthusiastic acclaim it deserves. It was not of course a "discovery." Neither was it the

first aerial exploration of the Pole. Admiral Byrd, with Floyd Bennett, flew over it in 1926, Roald Amundsen, Lincoln Ellsworth and Umberti Nobile crossed it in the dirigible *Norge* in the same year and in 1928 Nobile returned in the dirigible *Italia,* crossed the Pole a third time, was wrecked on his return trip and saved in the epic of rescue performed by the Soviet icebreaker *Krassin.*

The importance of the flight and landing of Professor Otto Schmidt and A. V. Vodopyanoff, one of the most famous of Russian aviators, and their companions consists rather in their having been the first to follow up a flight to the Pole with the attempt to establish the first permanent polar station, equipped with scientists, wireless and a landing field for planes. The latter is most necessary, for the Soviet believes apparently in "mass" tactics even in polar expeditions —four more planes are prepared to reinforce the first arrivals.

Dramatic as it undeniably is, this feat actually is only another step in the detailed and ambitious program for subduing the Arctic and sub-Arctic regions which the Soviet Government has been steadily and boldly carrying forward for years. With so much of its own territory lying in the far north, the U.S.S.R. seeks to work an economic transformation in this great area, opening up new regions and establishing new shipping services. The world has heard of the remarkable exploits of the *Krassin* and *Cheliuskin,* but the Arctic voyages of the icebreakers *Sedov, Litke, Malygin* and *Sibirakov* have been, perhaps, not less important. In 1934, for example, some thirty Russian expeditions with some forty ships and planes were active in the far northern regions and thirty-eight stations, many with large staffs, were set up on Arctic coasts and islands. And behind the large corps of scientists and sailors and airmen which it has trained for this work, has moved the government, founding new towns, breaking new paths. It is all part of the plan for unlocking the vast resources of the Soviet Union, creating new trade routes and perhaps even providing new strategic lines.

In its turn the work of the Russians logically folllows and extends the explorations of such men as Ellsworth and Byrd in the Arctic and Antarctic, by developing further the use of the airplane and laying firm foundations for scientific observation. Whether the hope that the Russians entertain for using the Pole as a base for a commercial air line from Moscow across the North Sea to San Francisco will materialize must wait upon these studies and a number of other experiments calling for courage and skill in high degree. It appears to be the belief of Professor Schmidt, who is the director of the Soviet Arctic Institute and Northern Sea Route Administration, and, it seems, the intellectual mainspring of Russia's bold pioneering ventures, that such a line will be practicable two years after the completion of surveys. In any event, a brave and auspicious beginning has been made and the world can take pleasure in laying aside all political considerations to applaud the courage and success of those who by employing the new tools of science and aviation have written this latest bright chapter into the history of man's conquest of nature.—*The Baltimore Sun.*

SOCIETIES AND MEETINGS

THE KANSAS ACADEMY OF SCIENCE

THE sixty-ninth meeting of the Kansas Academy of Science was held at the Kansas State College of Agriculture and Applied Science at Manhattan, Kansas, on April 1, 2 and 3, with Lawrence Oncley, professor of chemistry at Southwestern College, Winfield, Kansas, presiding. The committee on arrangements for this meeting consisted of E. C. Miller, chairman, Martha Kramer, E. C. Chapin and M. J. Harbaugh, all of Manhattan.

The meeting opened before an audience of about 800 with a demonstration of some new sound films which are suitable for teaching aids. This demonstration was followed by a showing of his original film on "How Things Grow" by W. J. Baumgartner, of the University of Kansas.

The first general session of the academy was held on Friday morning, April 2, at which time nine papers of general interest and eight papers on geology were presented. Thirty-five geologists and guests under the leadership of A. B. Sperry went on a field trip on Friday afternoon to examine some igneous outcrops near Riley, Kansas. At the same time the following sections met for hearing papers:

Botany, 19 papers, J. H. Doell, Bethel College, presiding.
Chemistry, 15 papers, L. E. Blackman, Kansas State Teachers College, Emporia, presiding.
Physics, 15 papers, Louis R. Weber, Friends University, Wichita, presiding.
Psychology, 13 papers, Edwina A. Cowan, Friends University, presiding.
Zoology, 33 papers, John Breukelman, Kansas State Teachers College, Emporia, Kansas, presiding.
Junior Academy, five clubs on program with Hazel Branch, University of Wichita, in charge and an attendance of 100.

On Friday evening, the annual banquet was held at the college cafeteria, with George A. Dean, the first vice-president, as toastmaster and 125 persons in atten-

dance. Public announcement was first made at the banquet of the establishment of the Albert B. Reagan endowment by a gift of $1,000 by Mrs. Otilla Reagan, wife of the late Dr. Albert B. Reagan, of Provo, Utah. Dr. Reagan, who has published more than 500 papers, chiefly in the fields of archeology and anthropology, particularly of North American Indians, died last May. After his retirement from his work in the Department of the Interior, Division of Indian Affairs, he was made special professor of anthropology at Brigham Young University. The income from the endowment which has been established by Mrs. Reagan is to be granted annually by the committee on awards to one or more members of the academy who apply for it for the purpose of completing and publishing scientific papers. Articles governing the administration of this fund were adopted at the business meeting. Mrs. Otilla Reagan was introduced at the banquet, following which Professor Roy Rankin told of the life and work of Dr. Reagan.

Mrs. Eusebia Irish, daughter of Benjamin Mudge, a founder and the first president of the Kansas Academy of Science, was likewise introduced. She spoke briefly of her distinguished father, who was so influential in early scientific work in Kansas.

President Lawrence Oncley gave the annual presidential address at the banquet on the subject, "Some Reflections upon the Teaching of General Chemistry." Following the banquet, the annual invitation address was given in the college auditorium by Charles F. Hottes, head of the department of botany at the University of Illinois, on "The History of the Bald Cypress and Redwood." This interesting address, which was illustrated by colored slides, had an attendance of approximately 750.

On Saturday morning, two general interest papers were given, followed by a symposium by the Committee on Conservation and Ecology upon the small area of unusual rock concretions near Minneapolis, Kansas, which the academy wishes made into a national park for preservation. Over 100 spherical sandstone concretions 16 to 24 feet in diameter, many of which are almost perfect spheres, lie more or less fully exposed. Walter H. Schoewe has sponsored the work of this committee and led the symposium, followed by W. H. Horr, Charles E. Burt and L. D. Wooster.

The symposium was followed by the business meeting. Several amendments to the constitution were adopted. The secretary reported the total membership to be 541, consisting of 10 honorary, 49 life members and 465 annual members; 105 persons joined the academy since the last meeting. The 1936 volume of the *Transactions* was in galley proof at the time of the meeting. The treasurer reported a balance of $546 and $2,452 in the academy endowment fund. The committee on awards, consisting of L. C. Wooster, *chairman*, J. C. Peterson and R. Q. Brewster, reported having made research grants of $50 to J. P. Puffinbarger, of the University of Kansas, and $50 to S. L. Loewen, of Sterling College. The academy contributed $25 to the fund of $75 supplied by the American Association for the Advancement of Science to make $100 for grants.

The nominating committee reported the following nominations to office for 1937–38:

George A. Dean, *president*, Kansas State College, Manhattan.
W. H. Schoewe, *president-elect*, University of Kansas, Lawrence.
H. H. Hall, *vice-president*, Kansas State Teachers College, Pittsburg.
Roger C. Smith, *secretary*, Kansas State College, Manhattan.
H. A. Zinszer, *treasurer*, Fort Hays Kansas State College, Hays.
Three additional members to the executive council: Lawrence Oncley, Southwestern College; J. H. Doell, Bethel College; and R. H. Wheeler, University of Kansas.
Editorial Board: W. J. Baumgartner, *managing editor* (reelected), University of Kansas; Frank C. Gates continues an unexpired term as editor-in-chief of the *Transactions*.
Associate editors: Louis R. Weber, Friends University, to fill unexpired term of W. W. Floyd; G. A. Kelly, Fort Hays Kansas State College.

Following the business meeting, the Kansas Entomological Society, which is affiliated with the academy as the section on entomology, held its thirteenth annual meeting, with D. A. Wilbur as chairman and R. L. Parker as secretary. Twenty-four papers were presented, with an attendance of seventy-five.

The Kansas and Nebraska chapters of the American Association of University Professors also met following the academy business meeting in cooperation with the academy this year, with an attendance of 90. D. A. Worcester, of the University of Nebraska, was regional chairman, while R. W. Conover, C. M. Correll and Kingsley Given served as meeting chairmen.

The Entomological banquet was held at the Manhattan Country Club on Saturday evening, with George B. Wagner as master of ceremonies. After words of greeting by Professor Dean to the group of 75, the local entomologists provided entertainment.

The following sectional chairmen were elected for 1937–38:

Botany, Miss Margaret Newcomb, Kansas State College, Manhattan.
Chemistry, Lloyd McKinley, University of Wichita, Wichita.

Entomology, Warren Knaus, McPherson, Kansas.
Physics, C. V. Kent, University of Kansas, Lawrence.
Psychology, O. W. Alm, Kansas State College, Manhattan.
Zoology, Claude Hibbard, University of Kansas, Lawrence.
Junior Academy, Oscar Klingman, Junction City.

Among the new committees appointed by President George Dean was a new Junior Academy Committee, consisting of J. R. Wells, Pittsburg, John M. Michener, Wichita, and Edith Beach, Lawrence, and a new committee to study the issuance of a series of natural history hand-books by academy members, consisting of Frank C. Gates, *chairman*, E. J. Wimmer and W. H. Schoewe.

A total of 307 members registered for the academy meetings, 52 for the university professors meeting and 72 for the entomological meetings.

The next annual meeting of the academy will be held during the spring of 1938 at the Kansas State Teachers College, Pittsburg. It was also agreed that the seventy-first meeting will be held at the University of Kansas, Lawrence, during the spring of 1939.

ROGER C. SMITH,
Secretary

REPORTS

THE UNION OF AMERICAN BIOLOGICAL SOCIETIES AND BIOLOGICAL ABSTRACTS

AT a meeting of the Council of the Union held in Atlantic City on December 28, 1936, E. V. Cowdry was elected president; G. W. Hunter, III, secretary; Ivey F. Lewis, treasurer; and W. C. Curtis, E. B. Krumbhaar and E. D. Merrill additional members of the executive committee.

The members of the Union are:

American Association for the Advancement of Science
  Section F, Zoological Sciences
  Section G, Botanical Sciences
  Section N, Medical Sciences
  Section O, Agriculture
American Association of Anatomists
American Association of Economic Entomologists
American Association of Immunologists
American Dairy Science Association
American Genetic Association
American Ornithologists' Union
American Physiological Society
American Phytopathological Society
American Society of Agronomy
American Society of Biological Chemists
American Society of Clinical Pathologists
American Society for Experimental Pathology
American Society for Horticultural Science
American Society of Ichthyologists and Herpetologists
American Society of Mammalogists
American Society of Naturalists
American Society of Parasitologists
American Society for Pharmacology and Experimental Therapeutics
American Society of Plant Physiologists
American Society of Zoologists
Botanical Society of America
Ecological Society of America
Entomological Society of America
Genetics Society of America
National Research Council
  Division, Biology and Agriculture
Poultry Science Association
Society of American Bacteriologists
Society of American Foresters
Society for Experimental Biology and Medicine

According to its constitution, the objects of the Union are ". . . to stimulate investigation in the field of biology, to organize and promote the interests of bibliography and publication, to deal with questions of general interest in the field of biology and in general to promote the solution of those broad problems which the specialized societies are not in a position to support effectively, and to do anything else which may serve these ends."

Under the presidency of W. C. Curtis, the Union sponsored *Biological Abstracts* and it is proposed to continue giving all possible assistance to this important project. A very encouraging feature of the Atlantic City meeting of the American Association for the Advancement of Science was wide-spread approval of the editorial management of *Biological Abstracts* and of the service which it renders. The biological sciences include many divergent specialties. To have them integrated in this way is highly desirable and one of our greatest needs if civilization is to profit by the so-called "life-sciences." That biologists generally are eager not only to give time and energy to the arduous task of careful abstracting but, in addition, to actually contribute financial support for necessary expenses was abundantly demonstrated. Of the societies meeting during the Christmas holidays, the American Society of Zoologists, the Botanical Society of America, the American Society of Parasitologists, the Genetics Society of America and the Ecological Society of America all voted an assessment on their members, in some cases mandatory, in others not mandatory. The American Genetic Association issued an informal request for aid. Moreover the Society of American Bacteriologists, the American Society of Naturalists, the American Limnological Society, the

Poultry Science Association and the Society of American Foresters made generous contributions from their treasuries; others still have the matter under consideration. A special committee of the National Academy of Sciences is cooperating with the Union and the National Research Council in a vigorous campaign to raise sufficient funds to permanently establish *Biological Abstracts* on a secure foundation. The membership of this committee is: Ivey F. Lewis, *chairman*, A. Parker Hitchens, C. E. McClung, Herbert Osborn, G. H. Parker and L. B. Wilson. The Union has requested the board of trustees of *Biological Abstracts* to submit a statement of the present status of *Biological Abstracts*. This is appended.

Last year the Union appointed, and decided to sponsor in the same way, a committee on biological science teaching, consisting of Oscar Riddle, *chairman*, E. V. Cowdry, H. B. Glass, B. C. Gruenberg and F. L. Fitzpatrick, whose efforts are directed particularly toward improvement in the teaching of all branches of biology in secondary schools.

Suggestions are invited from the member societies, and from all who are interested as to other services which the Union of American Biological Societies may properly perform.

PRESENT STATUS OF BIOLOGICAL ABSTRACTS

The members of the Board of Trustees of *Biological Abstracts* are: C. E. McClung, president; A. F. Woods, vice-president; J. R. Schramm, editor; Chas. M. B. Cadwalader, treasurer; I. W. Bailey, H. C. Bazett, A. F. Blakeslee, A. Parker Hitchens, C. A. Kofoid, Walter Meek and Herbert Osborn. Frederick V. Rand serves as secretary to the Board. The following statement is offered:

Underlying *Biological Abstracts* is a broad principle. Increasing volume and specialized character of new information has elevated integration and synthesis to the position of commanding problems. Among the many ways in which this integration is fostered in biology, none appears to be as permanently effective, economical and free from geographical limitations as a comprehensive abstracting service provided with excellent indexes. *Biological Abstracts* was therefore undertaken not as a passive bibliographic tool but as an instrument susceptible of development into a constructive force in the integrated development of the science.

The service, issuing its first volume in 1927 and its eleventh in 1937, was made possible by support from the Rockefeller Foundation. This subsidy expired in 1935. A review of the situation in 1935 by a special Committee on *Biological Abstracts* of the Science Advisory Board led to the conclusion that the value of the instrument was thoroughly established and that every means would be sought for its permanent support. This special committee, now a subcommittee of the Government Relations and Science Advisory Committee of the National Academy of Sciences, is endeavoring to develop a stable and adequate financial basis for *Biological Abstracts*. In these efforts the Union, the Board of Trustees of *Biological Abstracts* and the Division of Biology and Agriculture of the National Research Council are lending their fullest cooperation. Meanwhile the service is in a very precarious position, being maintained by temporary emergency measures, including financial contributions from the member societies of the Union, either through membership assessments or treasury grants.

Biological Abstracts may be said to be in process of development, with its objectives at the moment only partly realized but distinctly in sight. Not having been able to pay honoraria for abstracting, it has not achieved the desired uniform promptness. Payment of honoraria, long recommended by the editors, would correct this shortcoming. Availability of funds for honoraria would also enable *Biological Abstracts* to bring the abstracting of the research literature within its scope to satisfactory completeness.

Probably most serious has been the delay in the indexes. The editors rightly adhered tenaciously to the principle that the permanent reference value of the service depended almost entirely upon the quality of its indexes. The original organization of these indexes was a colossal task. Handicapped by inadequate funds, delays occurred. But the thorough ground work in the earlier indexes is reflected in more rapid progress on the later ones. Only one index is now in arrears, and it will appear in the summer of 1937.

It is generally agreed that these highly integrated indexes have achieved an unusual standard of excellence. Inconvenient as has been the delay in their appearance, the thoroughness of the work assures to the volumes of *Biological Abstracts* extraordinary permanent reference value. And now that the essential organization work is completed and the technique mastered, serious delays in indexes of future volumes are unlikely.

Biology is a diversified science. But the interdependence of its several branches is increasingly evident. Advances are linking together fields in fruitful and unpredictable ways, with a wholesome disregard of boundaries between traditional disciplines. The comprehensiveness of *Biological Abstracts* with its interlocking indexes is powerfully promoting this salutary integration. At the same time its sectional arrangement and detailed indexes adapt it to meet analytical needs.

Biology thus has an instrument which appears to

be admirably adapted to serve constructively its best interests, requiring only further development along the general lines indicated. The problem now is almost wholly a financial one. Contributing as volunteer abstracters and section editors, and often as subscribers as well, biologists individually, both here and abroad, have from the beginning lent very impressive support. This, and the increasing material contribution from the organized societies of biologists, is indicative of the wide-spread determination to maintain and develop *Biological Abstracts*. But, as clearly foreseen from the beginning, such support, including subscription income, probably at best can not provide more than one third of the funds necessary to maintain *Biological Abstracts* adequately, even in the immediate future. At the same time, such support on a still broader basis is indispensable to the present efforts to secure the necessary additional permanent funds from other sources.

The adequate solution of the financial problem of *Biological Abstracts* is admittedly difficult. But in view of the investment made, the service already rendered and the great potentialities ahead, it is incredible that it should now fail for lack of adequate financial support.

E. V. COWDRY

WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

SPECIAL ARTICLES

EXPERIMENTAL DETERMINATION OF THE ANTICONVULSANT PROPERTIES OF SOME PHENYL DERIVATIVES[1]

THE introduction of bromides and later of phenobarbital may well be considered the two greatest steps forward ever made in the practical treatment of the convulsive state. In view of the prevalence of the condition and the urgent need for better means of controlling it, there have been surprisingly few attempts to survey the field for even more effective medication. One difficulty has been to devise a standard means of producing convulsions in animals for preliminary studies. The use of convulsant drugs (for example, in the hands of Keith,[2] Elsberg and Stookey[3]) have not been thoroughly satisfactory. Fulton and Keller[4] have compared the effect of various anesthetics on the excitability of the cerebral cortex to electrical stimulation. Krasnogorosky[5] has used an arrangement of electrodes somewhat similar to ours for the purpose of producing experimental convulsions, and Spiegel[6] has designed an apparatus for determination of the convulsive reactivity by gradual electrical stimulation of the brain with the skull intact, using electrodes placed upon the eyeballs. We are indebted to Dr. Frederic A. Gibbs for suggesting that a modification of these methods could be used for our purposes and to Dr. Paul Hoefer for help in devising one which has proved simple and practical.

As used at present, the stimulator consists of a 45-volt radio battery, discharging through a commutator operated by a motor and through a potentiometer of 50 ohms. One end of the potentiometer is wired through a 0–50 milliammeter to an occipital electrode and the sliding connection is wired to a mouth electrode. Thus, it is possible to apply shocks at various speeds and at various amperages (Fig. 1).

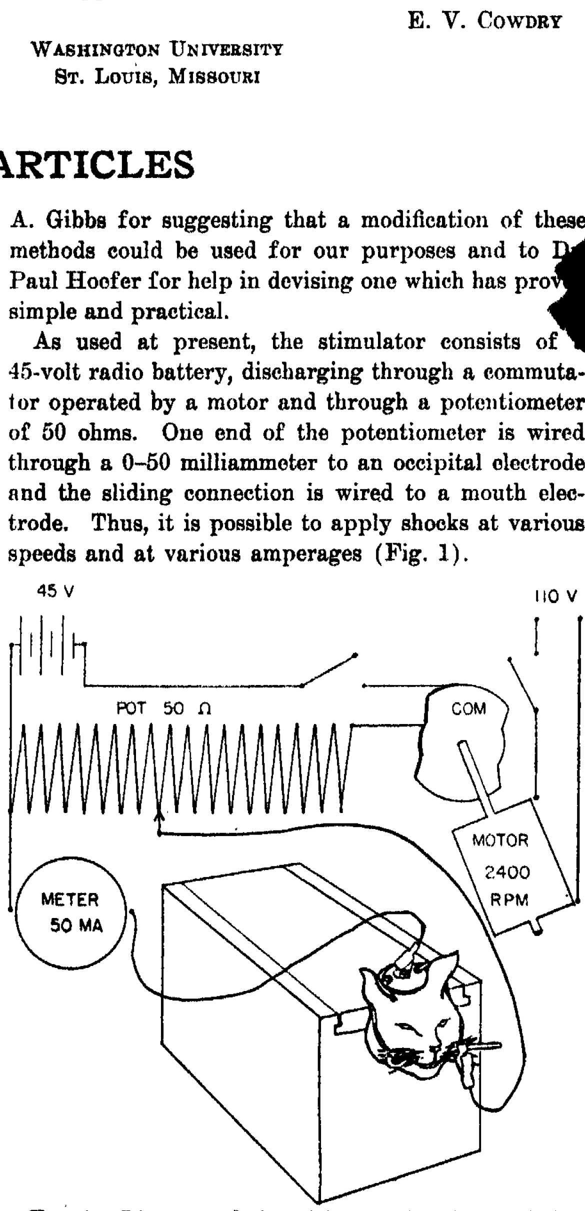

FIG. 1. Diagram of the wiring employed, permitting an interrupted current of determined amperage to be applied through an animal's head to determine the threshold for convulsions.

[1] From the Department of Neurology, Harvard Medical School, and the Neurological Unit, Boston City Hospital, Boston. This work was aided by a grant from Parke, Davis and Company.

[2] H. M. Keith, *Am. Jour. Dis. Child.*, 41: 532, 1931. Also, *Jour. Pharmacol. and Exper. Therap.*, 44: 449, 1932.

[3] C. A. Elsberg and B. P. Stookey, *Arch. Neurol. and Psychiat.*, 9: 613, 1923.

[4] J. F. Fulton and A. D. Keller, *Surg. Gynec. and Obstet.*, 54: 764, 1932.

[5] N. I. Krasnogorosky, International Physiological Congress, Leningrad, Moscow. August 9–17, 1935. Summaries of Communications, p. 213.

[6] E. A. Spiegel, "Quantitative Determination of the Convulsive Reactivity by Electrical Stimulation of the Brain with the Skull Intact." *Jour. Lab. and Clin. Med.* (to appear).

In practice, cats have been used as test animals, confined in cat boxes. One electrode is a stout wire bit placed in the animal's mouth, the other a metal plate between the ears, upon an area of fur which has been thoroughly moistened with soap solution. The two electrodes are kept in place by a simple bridle of string. Experiment shows that convulsions are produced at a slightly lower amperage if the speed of the commutator is increased up to 80 contacts per second (the limit available with the apparatus employed) than at lower speeds. The current is turned on for 10 seconds for each test; if the stimulus is above threshold, a convulsion will often begin in less than half this time. As there are no means of predicting accurately what the resistance of the circuit will be, the slider is adjusted to the desired milliamperage after the switch is closed.

The animals appear to be unconscious while the current is flowing, though naturally rigid. The method appears to involve no undue cruelty, and indeed is similar to that used for executing stray animals by some animal protective societies. A convulsion is marked by the persistence of tonic and clonic movements for a variable interval after the current is turned off, dilation of the pupils and subsequent stupor. Each animal has a characteristic threshold—usually between 6 and 15 milliamperes under the conditions stated—which seldom varies spontaneously more than 10 per cent. on any one day, and usually less than 25 per cent. from one day to another. If 5 minutes is permitted between shocks when no convulsion is produced, and an hour after each convulsion before the next shock, several determinations of threshold may be made daily.

The apparatus would probably be almost as efficient and somewhat simpler if a transformer of the "Variac" type were used on an alternating current line through a milliammeter. The difference in effectiveness between a 60-cycle current and the 80 shocks per second used at present can not be great.

The anticonvulsant effect of most of the common drugs has been studied by this apparatus, continuing the work of Spiegel.[6] Under the conditions of the experiment, it is easy to demonstrate that a dose of sodium bromide sufficient to prevent a cat from walking (about 2 gm) will raise the convulsive threshold only about 50 per cent., while a dose of phenobarbital producing similar symptoms (about 0.1 gm) may treble or quadruple it. Cats so protected may survive shocks of an intensity which proves fatal to untreated animals. Comparable doses of other familiar barbiturates have little anticonvulsant activity. This, and the fact that Harrison, Mason and Resnik[7] have produced evidence that the conjugated phenols are responsible for the motor depression of uremia suggested a search among phenyl derivatives as well as among standard hypnotics.

Accordingly, a large number of the less toxic phenol compounds was studied. They included phenyl, cresyl and tolyl sulfonates, benzoates, ketones and esters of such radicals as carbamic, malic, barbituric acids and hydantoin. The compounds which appear to have the greatest anticonvulsant activity combined with the least relative hypnotic effect of those tested so far are diphenylhydantoin, acetophenone and benzophenone.[8]

Whether the drugs found most effective under the conditions of the test will also prove of value in clinical practice remains to be seen. The experimental method appears, however, to constitute at least a provisional index of their activity.

Tracy J. Putnam
H. Houston Merritt
Harvard Medical School

[7] R. T. Harrison, M. F. Mason and H. Resnik, *Jour. Clin. Invest.*, 15: 463, 1936.

[8] H. H. Merritt, T. J. Putnam and D. M. Schwab, Material in preparation.

EXTRACTION OF THE NITROGENOUS MATERIALS FROM DRIED GRASS[1]

As a part of a quantitative study of the nutritionally essential amino acids in the more important forage plants, it was considered highly desirable if not absolutely necessary to find a method for removing all the protein from such materials.

It is the object of this paper to report that extraction of the air-dry grass in a Soxhlet apparatus with 90 per cent. formic acid brings most of the sample into a solution which includes *all* the nitrogen. This procedure was developed as a result of some experiments in which several reagents were tested by agitating samples of grass at room temperature with successive small portions of each reagent. Ninety per cent. formic acid was found most effective, removing about 88 per cent. of the total nitrogen. Since repetition of this treatment removed further small quantities of nitrogen, it was decided to try the Soxhlet method of extraction. When the charge was mixed with a suitable material to facilitate percolation, such as 50-mesh ground glass, the Soxhlet extraction was completed in three to eight hours. Aliquots of two such extracts, representing 0.2 g of grass, contained 5.21 and 5.07 mg of nitrogen or an average of 100.8 per cent. of that present in the grass. Such extracts are being examined to determine their usefulness in a study of the nutritionally essential amino acids.

It is interesting to note that in a material containing

[1] Contribution from the Bureau of Plant Industry in cooperation with the Bureau of Animal Industry. The possibility of using formic acid as a protein solvent was suggested by Dr. H. W. Titus, of the latter bureau.

22.2 per cent. of crude fiber, the residue from this extraction averages 21.9 per cent., but *it must not be inferred* that the two substances are identical.

In a limited search of the literature two pertinent papers by Dr. R. H. Carr were found. In the first, "Structure of Plant Compounds and Solubility,"[2] it is reported that not much protein dissolves in cold 75 per cent. formic acid. In the second, "Preparation of Transparent Specimens of Leaves, Worms, Bees, Butterflies, etc."[3] it is reported that cold 90 per cent. formic acid dissolves most of the proteins of both plant and animal tissues. There are no analytical data in either of these papers.

HERBERT L. WILKINS
U. S. DEPARTMENT OF AGRICULTURE
BELTSVILLE, MD.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

EGGS OF FRESH-WATER FISHES SUITABLE FOR LABORATORY STUDIES

BRINLEY and Creaser, in 1931, published a short article on eggs of fresh-water fishes suitable for physiological research.[1] Since that time, one of us (F. J. B.) has continued the study with the hope of extending the list and adding new species that would produce eggs at other times, so that there would be a continuous supply of eggs during the entire year.

Trout and Salmon: Eggs or embryos of the brown (*Salmo fario*) and rainbow (*S. irideus*) trout, and the Atlantic salmon (*S. solar*) have been used by a number of investigators and may be readily obtained from the various state hatcheries during the late fall and early winter months. The eggs in the "eyed" state can be shipped long distances in cool damp moss packed in thermos jugs.

If running, cool spring water is not obtainable in the laboratory, the embryo may be kept until after the yolk is absorbed (March or April) in shallow dishes, such as finger bowls, in a refrigerator, maintained at a temperature of 8 to 10° C. A supply of pond water should be kept in the refrigerator, and water in the dishes should be changed daily. The dishes must be kept clean and all dead embryos removed. The eggs vary in size from 5–8 mm in diameter, and not more than 50 eggs should be kept in a finger bowl. The eggs are covered with an opaque shell which must be removed in order to see clearly the enclosed embryo. It has been found that the embryos develop faster, with less mortality, and that the dishes are more easily kept clean from fungus and scum if the shells are removed as soon as they are received from the hatchery. As the fish develop and the gills begin to function, the water should be filtered to remove any scum or fungus, which, when taken into the mouth of the fish during respiration, will clog the gills and result in suffocation. If this accumulation on the gills does occur, the stringy scum can be removed by gently pulling and working it loose from the gills with dissecting needles and fine pointed forceps. This condition has been erroneously called a fungus disease by several authors.

Great northern or common pike (*Esax lucius*) and the wall-eyed pike (*Stizostedion vitreum*) spawn in the early spring, and their eggs may be obtained from hatcheries during March and April in this latitude and kept under the same conditions as stated above. These eggs are much smaller, averaging about 3 mm in diameter. The wall-eyed pike embryos become very active as soon as the shells are removed, therefore they are difficult to study and their use for physiological investigation is rather limited. The egg of the common pike is well adapted for class and research use.

Eggs of the European carp (*Cyprinus carpio*) may be taken in large numbers by collecting those that are naturally spawned in the shallow water along the shore of lakes or ponds. Spawning takes place in early to mid-morning and the males can be observed chasing the females in the shallow water. It has been reported by Forbes and Richardson[2] that 400,000 to 500,000 eggs have been taken from a four- to five-pound female. By observing the fish at spawning time, fertilized eggs may be collected shortly after being laid. The adults may also be seined at the time of spawning and the eggs stripped from the female and fertilized by sperm from the male.

The eggs are considerably smaller than the pike, and there is a transparent jelly-like substance between the egg shell and the embryo, which interferes with the removal of the shell. The jelly does not adhere to the embryos and can be picked off after removal of the shell. The long narrow yolk sac is attached almost to the anal opening. The embryos are very active and undergo numerous winding and bending movements of the tail which make them difficult to observe under the microscope.

Dates at which fresh-water fish eggs may be obtained and kept in the laboratory:

[2] R. H. Carr, SCIENCE, 69: 407–8, 1929.
[3] R. H. Carr, SCIENCE, 83: 355–6, 1936.

[1] F. J. Brinley and C. W. Creaser, SCIENCE, 74: 295–296, 1931.
[2] S. A. Forbes and R. E. Richardson, Natural History Survey, 1908.

March and April: Yellow perch (1); wall-eyed pike; common pike. *May and June:* European carp.

June and July: Log-perch (1); straw-colored minnow (1); common shiner (1). *October to April:* Trout and salmon.

FLOYD J. BRINLEY

NORTH DAKOTA STATE COLLEGE

ACETO-CARMIN MOUNTING MEDIA

BELLING'S aceto-carmin technique,[1,2] which has been so valuable for a quick examination of meiotic divisions, has proven to be especially useful in the investigation of the giant chromosomes in the salivary glands of the Diptera. The chief disadvantage of the method lies in the fact that the preparations are temporary and the specimens can not be preserved without further treatment. Often specimens so prepared are too valuable to be discarded and a number of methods have been devised for transforming these temporary preparations into permanent slides. (McClintock,[3] Steere,[4] Buck,[5] Marshak,[6] etc.). These methods serve the purpose for which they were designed, but they lose the chief advantage of Belling's original technique, its extreme simplicity and speed.

The aceto-carmin technique can be greatly improved and the preparations made permanent by adding to the fixing solution certain inert substances which do not alter the fixation image but which serve as mounting media when the acetic acid and water evaporate. A number of such substances are available, *i.e.*, dextrose, gelatin, glycerine, gum-arabic, pectin, etc. A detailed investigation of these water-soluble mounting media is now in progress. Two mixtures, however, have already shown their usefulness.

(1) The specimen is macerated on a slide in a drop of Belling's aceto-carmin (a saturated solution of carmin in 45 per cent. acetic acid plus a trace of iron). Then several drops of the following solution are added:

Belling's aceto-carmin	80 cc
Karo Corn Syrup (Dextrose)	10 cc
Certo (Pectin)	10 cc

(The commercial products in the mixture can be purchased at any grocery store.) The preparation is then heated, as in the Belling technique. The coverglass can be pressed down until the specimen has reached the desired thinness. If an excess of the solution is squeezed out around the edges of the coverglass it need not be removed, as it forms an excellent sizing and dries as hard as balsam.

(2) The following mixture may be used alone and thus it reduces the fixing, staining and mounting to a single operation. It may be used undiluted or it may be diluted with Belling's aceto-carmin in various proportions (3:1, 1:1, 1:3, etc.), depending upon the nature of the specimen to be examined. With greater dilutions more fluid should be used to allow for the greater evaporation of water and acetic acid.

Acetic acid (glacial)	50 cc
Water	50 cc
Glycerine	1 cc
Gelatin (powdered)	10 grams
Dextrose	4 grams
$FeCl_3$	0.05 grams
Carmin	To saturation

The gelatin should be dissolved in the water and the other components added. The mixture should be boiled and filtered, just as is done with Belling's solution. As the acid and water evaporate, the medium becomes as firm as balsam and, unlike the familiar glycerine-jelly, it will not liquefy, even when heated to 80° C.

CONWAY ZIRKLE

MORRIS ARBORETUM AND
DEPARTMENT OF BOTANY
UNIVERSITY OF PENNSYLVANIA

[1] *Amer. Nat.*, 55: 533, 1921.
[2] *Biol. Bul.*, 50: 160, 1926.
[3] *Stain Tech.*, 4: 53, 1929.
[4] *Stain Tech.*, 6: 107, 1931.
[5] SCIENCE, 81: 75, 1935.
[6] *Amer. Nat.*, 70: 406, 1936.

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THE SOCIAL RESPONSIBILITY OF THE ENGINEER[1]

By Dr. F. G. COTTRELL

RESEARCH ASSOCIATES, INC., WASHINGTON, D. C.

IT is with very genuine pleasure and appreciation that I come here to-night, for in thus responding to your friendly and generous invitation and in adopting your chairman's suggestion for the subject and title of my remarks, I feel that it is primarily as a group representative for certain social ideas or way of life rather than as an individual that I am speaking to you.

There seems to be a wide-spread feeling, with which I heartily sympathize, that scientists and engineers as a class have a peculiar responsibility to society for leadership in certain directions which they have on the whole as yet, perhaps, not fully appreciated.

While this has been a matter of long standing, the acute social and economic problems facing the world to-day emphasize the importance of an awakening to the issue.

[1] Address on the occasion of the presentation of the Washington award at a meeting of the Western Society of Engineers, Chicago, February 23, 1937.

Thorstein Veblen has perhaps most clearly sounded this challenge in "The Engineers and the Price System." The gist of Veblen's plaint is that while scientists and engineers are largely responsible for our material progress in the present age, they are so preoccupied and satisfied with these functions that they allow themselves to become mere cogs in the social-economic machine, which falls thereby all too readily and exclusively into hands whose training has been purely in trade and finance and thus dominantly directed to the goal of profits as contrasted with use or service.

There is sound wisdom in Veblen's exhortation of the scientists and engineers to take a more active interest and responsibility in the social economic side of life, for both by temperament and training we have a right to expect them to think most naturally in terms of service and utility.

However, the young engineer in college and just as he is emerging therefrom is in a very difficult situation to-day with regard to these deeper lying social responsibilities of his profession, because our whole social order, if not actually undergoing a profound fundamental change in the relative weight assigned to property and human values, is at least a battle ground for the forces representing the struggle between conservative and radical thought and interest, divided along just these lines of cleavage.

The engineer's work has to do naturally with material things, and with material things on a large and expensive scale—in other words, primarily with property values. He thus comes in ever increasing degree, as his experience and responsibilities multiply, to be thrown with and have to look to men whose primary training and duty it is to consider everything from this property aspect. Our whole industrial system has perforce been built up chiefly upon this plan, while its impacts on human needs and relations, in so far as not automatically adjusting themselves under a *laissez-faire* system, have been vaguely left to the professional sociologists, economists and legislators to ponder and attempt solutions through education of the public and regulatory legislation.

What I want to bring out is the crying necessity and splendid opportunity for the young engineer of creative imagination and moral courage to join forces with his brother specialists from the humanitarian side and thus insure a really comprehensive picture of what *homo sapiens*, in this year of grace 1937, should be driving at as the immediate and conscious goal for the species.

I believe we must fairly face the fact that whether we like it or not, our fundamental and generally accepted basis for morality, including the fundamental principles of democracy, has finally run head-on into some of our most solidly established legalistic extensions and interpretation of man's earlier, simpler and more personal conception of property ownership. Ironically enough, the doctrine of sanctity of property apparently originated in the mind of man largely to protect him against the dangers of unemployment. But now in its modern extensions to corporate ownership it is receiving chief blame from many for national unemployment.

That is to say, from the democratic and *laissez-faire* standpoint, before the era of mass-production and giant power, the recognition of the essential sanctity of private property and the obligation of the state to protect the individual therein against marauders large or small, became the individual's best possible guarantee that with ability, industry and willingness to work, he could always create and maintain for himself and family a home and workshop furnishing shelter, productive employment and, through the latter, such other necessities and luxuries of life as to give him his fair chance in reference to the living standards of his age.

The coming of the industrial revolution and centralized factory system, first in Europe and later in our own country, followed many years later, but especially in this country, by the final closing of the frontier through progressive pioneering with the eventual absorption into private ownership of all worth-while land and other natural resources, tremendously reduced the significance of property ownership by the average man, in so far as security of employment was concerned. To be sure, there is still room for some little workshops and individually owned factories, but their possible number relative to population is so pitifully small that they are no longer a significant factor in unemployment. Even for the skilled craftsman, individual ownership of his tools has steadily waned almost to the vanishing point. The real tools of major industry are now so exclusively held in ever-growing corporate ownership that the relation of property rights to mass unemployment may justly be considered entirely from this standpoint.

Thus over the years the legal fiction of the corporation has gradually insinuated itself between the artisan and his tools. Nor would his saving and investment in his share of these tools through ownership of the shares of the corporation give him, under existing law, any assurance of access to these tools whereby to earn his livelihood. Thus has one of the most fundamental and significant meanings of property rights undergone a terrifying change for the vast majority of our population and largely without our realizing it.

Here again the engineer should be in a most strategic position to intelligently yet sympathetically understand and interpret the situation to the ultimate authorities, both public and private, for it behooves us to remember in all this that the corporation as a fictitious legal person is the creation of the state, and it has been largely through the interplay of both physical and human engineering that corporate methods and management have now come to play so large a part in our national life and in our destinies as individuals.

These corporate structures and methods have certainly been a most powerful, if not indispensable, tool in the development of present-day science and engineering; but I think it is safe to say that the public, as a whole, to-day has greater confidence and respect for the ability and judgment of the engineer than for that of the business and financial management. In a sense the engineer stands as a connecting link between the public and the management, for the engineer in dealing more closely with physical details comes also more closely in contact with labor and the human side of these problems, and this is the aspect which the late

depression has so vividly shown us to be the part of our industrial structure which most needs attention and revision.

It is true, the fundamental conception and even the structure of our corporate law has come down to us with little change from the Romans, beginning there with the state and its minor subdivisions and extending to various social groups, but it is only the last half century which has seen its full flowering into the dominant and almost universal form of larger business undertakings.

The legalistic conception of the corporation as a *fictitious person has apparently left even to the present* day much interpretation still pending as to how completely the corporation is to assume not only human rights but human responsibilities. Perhaps the corporation is only showing a human characteristic in tending at times to stress its rights more than its responsibilities, feeling perhaps, again quite humanly, that the public, in the long run, can adequately take care of its own interests. However, there seemed until recently to have been a rather general, even if tacit, assumption that the more personal and intangible elements of human character and responsibility should hardly be looked for in a corporation, as tersely expressed in the old and well-worn saying that it "has neither a body to be kicked nor a soul to be damned."

But under the growing intricacy and intimacy of corporate relations with every detail of human life, may we not logically expect the public to progressively demand a higher and higher development within the corporate brain or management of something more analogous to what we think of as the finer and more intangible portions of human personality and responsibility? It seems to me that in his opportunity to help develop and rationalize some of these tendencies, the engineer holds a unique position both from his training and his peculiar position in the corporate structure. He is under less direct pressure than the business management to act exclusively under the profit motive, but is distinctively associated in everybody's mind with the function of service.

With an over-dominant financial- and promotional-minded management, he may, it is true, be under considerable pressure to focus these service efforts not so much on broad utility to the ultimate consumer nor improvement in working conditions of the staff and labor force, but rather with a single eye to increase profits and decrease costs at any cost. Just here, however, comes perhaps his real opportunity for social service in quietly and tactfully resisting undue pressure in this regard, even if it means a certain amount of hardship and risk to his advancement or even his position itself. In the extreme case, he may have the decision to make as to whether he can accomplish more for the general good by staying on where he is and systematically exercising this influence for whatever gains he may thereby be able to accomplish or whether he will be more useful on the whole by stepping out in favor of some one either more pliant or already committed to the management's point of view, while he himself seeks more promising soil in which to plant or cultivate these newer challenging variants of our social evolution.

Fortunately there is already a great deal of such ground to build upon, and it distinctly represents a two-way channel of exchange. I know of nothing *more inspiring in business and industry than to* see the deep-rooted and sincere loyalty of many employees and officials to their corporations. They, at least, certainly sense them as something more than a purely fictitious personality. On the other hand, there is an ever-growing circle among the corporations coming to appreciate their more human responsibilities in a deeper and deeper sense, and making every effort to find ways of expression. But especially in the larger corporations this often becomes a herculean task, chiefly from the size of the organization and the background of legal tradition and conservatism built up over the years out of our earlier limited interpretation of corporate personality. Where these traditions have been most directly broken through and a more progressive attitude established, it can usually be traced back to the presence of one or more outstanding individual personalities within the corporate management and staff, who have gradually built up their circle of sympathetic and vigorous spirits about them working in this direction. And here again is where the engineer can play so strong a part not only in his primary leadership in the matter, but in his helpful cooperation with others, both superiors and subordinates, in working to establish such traditions.

In town and village industries of old, owners, workers and consumers blended into a single compact community, the three classes largely overlapping. With the coming of our national corporations, all this has changed and in the typical case the three classes are quite distinct, though of late years definite and even strenuous efforts have been made by certain corporations to again interrelate the groups, as by stock allotments under favorable conditions to employees or stock sales campaigns among the consumers or clientele, as notably, for instance, by the American Telegraph and Telephone Company and other utilities. A still older and more complete application of the principle is, of course, the mutual insurance company. But this is too special a case to serve as a general pattern.

Of much more significance as a widely applicable pattern is the consumer cooperative movement, which had its origin, strangely enough, in almost exactly its

present-day corporate form through the registration on October 24, 1844, of the "Rochdale Society of Equitable Pioneers" in Toad Lane of this little factory town in northern England. Its growth, though steady and important, has been so unspectacular that its possible wide-spread importance as a social-economic factor has crept on us rather unawares, especially in this country, until within the last few years. But the prominence that it is now receiving in both the public and the technical press is rapidly acquainting all classes with its history and present status. Its world-wide strength has naturally sprung from the people with small incomes, and its already impressive world-wide manufacturing and merchandising operations are controlled and directed almost exclusively by men who have risen modestly from the ranks. Though now claiming to serve over two hundred million people throughout the world, it has the distinction of a remarkable degree of all-over efficiency coupled with strict adherence to its original severely democratic principles. As a background against which to examine our own national typically capitalistic business structure, it furnishes much food for reflection. In fact, so much so that of late months it has been freely asserted in several of the national trade journals that certain of our largest chain stores and mail order houses were seriously considering the expediency of remodeling their structure and customer relations very much along these same lines.

As a strongly suggestive study in contrasts, I would earnestly suggest to my socially minded engineer friends the worthwhileness of becoming thoroughly acquainted with this movement's history and present rather amazing growth in this country, particularly among the farming element. My reason for saying this is not that the movement has notably invaded the engineering field, particularly in the latter's more pioneering aspect, but rather for just the reverse reason, namely, that it has gone so far in other directions without apparently attempting or encouraging any bold pioneering of the engineering or fundamental science research type. This is entirely natural and to be expected, since the most dominant principle running through the movement as a whole, and which has undoubtedly contributed most to its stability and steadiness of growth, is the sustained and consistent effort to eliminate speculative motive both among its members and in the organization itself. This may prove the very factor which will limit its ultimate growth in displacement of typically capitalistic industry as we know it to-day. For it is in pioneering in new technical and industrial developments which at the start seem too uncertain in their results to be considered anything but speculative that the combination of high engineering skill and American methods of finance and management has been most successful and won world-wide acclaim.

It may be that the combination or rather working side by side of these two strikingly contrasted industrial systems is what we shall come to. The one under individual initiative would provide for constant pioneering and development of the frontier of applied science and industry, thus insuring the element of diversification in both products and human activities under the frankly exciting and stimulating conditions of typical pioneering, with all its traditional hazards and rewards, its headaches and waste for those who have the temperament and the hardihood to consciously and with deliberate choice elect this road. The other, the Cooperative, perhaps less spectacularly but none-the-less importantly would take over the industries and improvements thus established as they gradually become standardized, and thus freed from their original speculative aspects, eliminate the waste of excessive competition, advertising and promotion, guard against paying unjustifiable tribute to any special interest or group, and give the great, relatively colorless but none-the-less deserving consuming public at last an impersonally measured fair equivalent for its money or its services in return for such goods and services as can be produced and exchanged in this standardized way.

Here again, I believe, in the interrelation of these two groups and the establishment of their most fitting and efficient boundary relation is a splendid opportunity for the studies of the real engineer who knows not only his physics and his chemistry, but can judge and weigh human and service values as well. For verily there is a place for everything and we shall all be happier as each thing moves at least toward its allotted place.

Somewhat as the consumers cooperative movement has already found this large and important place for itself in the field of well-established household commodities alongside of ordinary capitalistic business and industry, there is also another, as yet much less pretentious and more tentative set of experiments being made over on the side of strenuous scientific and industrial pioneering, which have particularly interested me over the past 30 years and perhaps largely influenced the view-point presented to you this evening.

This group is probably best known to most of you through the industrial research foundations of various universities. My own most direct experience has been with the Research Corporation of New York City and its two-year-old little brother, Research Associates, Incorporated, in Washington, D. C. These are both non-profit business corporations, if you will permit such an apparently self-contradictory definition; meaning in any case that while they attempt to func-

tion in the same manner and general field as any privately owned and ethically operated business, they pay no dividends to personal stockholders. All income above expenses not held for reserves or needed for operating capital is expended currently to aid scientific and educational institutions in the prosecution of research.

Briefly, these two corporations may be said to hold a place and typify a new class midway between such privately endowed research and welfare foundations as Carnegie, Russell Sage, Rosenwald, and the like on the one side, and university research foundations, such as those at Wisconsin, Purdue and, more recently established, Ohio State on the other. They differ from the first category in starting with no large monetary endowment, that interest or dividends on securities purchased as investment are not intended ever to be a significant factor in their income, but that normally they earn their way currently through services in invention development and production for use.

They differ from the university foundations on the other hand chiefly by being entirely free from commitments to any one institution and thus being able to work with any and all of them, either individually or collectively. Also as yet the university foundations appear to have been conceived and administered almost exclusively from the standpoint and hope of revenue for further scientific research in the universities than with definite intent to use them as laboratories in social economics, which latter I have particularly tried to emphasize as the outstanding opportunity and characteristic among the purposes of Research Corporation and the Associates. That is, they are frankly willing to risk or even sacrifice on occasion possible legitimate profits from the licensing or operation of patents or developments if thereby a more important public service can be rendered by demonstrating the relative value and pertinency of proposed reforms in business and social administration of such rights, monopolies or other social-economic structures as the corporation may control or operate at a given time.

It is this latter aspect of the corporations' purposes and activities that is felt to be the most nearly unique up to the present time, and these it is hoped will eventually spread to other existing or yet to be created organizations, for this appears a most promising but neglected field of social-economic endeavor and research. In fact, I feel my main justification for being here to-night is what it may mean for the stimulation of just such activity. Perhaps the most impressive lesson that 25 years' experience with Research Corporation has driven home to us is how small a part of the field any one group can or should try to cover. Decentralization of projects and variety of approach, with free and active exchange of knowledge and experience, constitute the ideal program. Each new project of course presupposes sound worth-while new ideas for its technical background and adequate leadership ready to stay with them through thick and thin, but that is just what red-blooded engineers are supposed to have.

(To be concluded)

OBITUARY

WILLIAM MORTON WHEELER

WILLIAM MORTON WHEELER, professor of entomology, emeritus, at Harvard University, died suddenly in Cambridge, on April 19, in his seventy-third year.

Professor Wheeler was born at Milwaukee, Wisconsin, on March 19, 1865. He first attended public school but later transferred to Engelmann's German Academy and graduated from the German-American Normal School, which was appended to the academy. Even as a boy he was intensely interested in natural history and haunted the old museum at the school. In 1884, an incident occurred which was to influence his whole subsequent life. This was the visit to Milwaukee of Professor H. A. Ward, of Ward's Natural Science Establishment in Rochester. Ward brought with him a collection of stuffed and skeletonized mammals, birds, etc., with the idea of having the academy museum converted into a free municipal museum. Then a boy of 19 years, Wheeler helped Professor Ward prepare the collection for exhibition and was offered, and promptly accepted, a position in the Rochester Establishment. His duties consisted of identifying, listing and arranging collections of birds, mammals, shells, echinoderms and sponges. The catalogue of shells which he then prepared is still used by conchologists. In the following spring (1865) he left Ward's and returned to Milwaukee, starting his career as a teacher. Dr. George W. Peckham, who had been making studies on spiders and on the behavior of wasps, induced him to accept a position as teacher of German and physiology in the Milwaukee High School, of which Peckham was principal. Within a very few years the Allis Lake Laboratory was established near the high school, and Professor C. O. Whitman was appointed its director. One of the assistants at the laboratory, Dr. William Patten, taught Wheeler the latest embryological technique and suggested that he investigate the embryology of insects. This resulted (1893) in the publication of Wheeler's "Contribution to Insect Embryology," now recognized as a classic.

Meanwhile, however, the Milwaukee Public Museum

had been established, and in 1887 Wheeler, at the age of twenty-two, was appointed its custodian. He held that position until 1890, when he accepted a fellowship at Clark University under C. O. Whitman. In 1892 Wheeler received his Ph.D. from Clark University, his dissertation being the embryological treatise previously mentioned. The following year (1893–94) he studied at Wurzburg, at Liege and at the Naples Zoological Station. On his return to this country he was appointed instructor in embryology at the University of Chicago, and in 1896 was advanced to assistant professor. In 1899 he went to the University of Texas as professor of zoology. It was while there that he became especially interested in ants. Four years later (1903) he was selected as curator of invertebrate zoology at the American Museum of Natural History in New York. In 1908 he came to Harvard as professor of economic entomology. From 1915 until 1929 he was dean of the Bussey Institution, a graduate school of the university for research in applied biology. In the year 1924–1925 he was exchange professor at the University of Paris, and from 1926 until his retirement in 1933 he was professor of entomology and associate curator of insects at the Museum of Comparative Zoology.

Professor Wheeler's bibliography contains 467 titles. Many of these papers are concerned with the classification, structure and behavior of ants, but a considerable number deal with problems of embryology, evolution, parasitism and the social life of insects in general. Several of these publications appeared in book form, the more notable ones being: "Ants, their Structure, Development and Behavior," "The Social Insects, their Origin and Evolution," "Foibles of Insects and Men" and "Demons of the Dust, a Study of Insect Behavior."[1]

Wheeler had served his apprenticeship as a naturalist before his formal education in zoology really began, and this was perhaps the greatest good fortune of his life. Indeed many of his friends feel, and have always felt, that the full development of his great qualities was in this way facilitated and assured. In thought and feeling he was a practitioner *and* a theorist; a specialist of the first rank, and, in the ancient sense, a philosopher; a great professor, a man of vast encyclopedic learning and the least pedantic of men; a diagnostician of genius who could instantly recognise the significant patterns in things and events, but who confirmed his conclusions by meticulous and systematic observation and study. He always had and never lost satisfaction in the pursuit of minute detail and in the accumulation of facts, so that hard work was a necessity of his being, but he could set no limits, within his wide competency, to the scope of his thought or to its sources or to its reference. All these traits, or at least their full development, he believed partly the result of his peculiar training, and he was in the habit of attributing similar things to similar experiences in other cases than his own.

Observation of the social insects in the field led Wheeler—it could not fail to lead such a man, so conditioned and so oriented—to ecology, to psychology and to sociology. He worked long and hard at insect ecology, insect behavior and insect sociology, and in so doing found a most acceptable complement to his taxonomic work. But more than this, he made of himself a learned sociologist and psychologist and a master of the comparative branches of these sciences. It was such studies especially that directed his later thinking about evolution, that made him sceptical of the sufficiency of experimental evidence against the inheritance of acquired characters, that tempered his enthusiasm for the results and theories of the geneticists as a sufficient explanation of the mechanism of evolution, and that won his sympathy, warm though qualified, for the theory of emergent evolution. These studies also chiefly determined his philosophical position, so different from that of many of those who base their position on mathematics and the physical sciences. Wheeler, like the great physicians, could not forget the inconceivable complexity of things as they are and the intricacy of the web of events, but he possessed that intuitive and imaginative understanding which is the naturalist's compensation for his lack of the clear analysis of the physicist. Wheeler's philosophical position was, accordingly, chiefly the result of a naturalist's disciplined imagination and of vast first-hand acquaintance with animals and their behavior.

He was a man of letters. Possibly the most widely read member of his university, and in this respect unique among the men of science, he was also a distinguished prose writer. Both facts were, or seemed to those who knew him, very certainly and deeply characteristic, nothing less than necessary expressions of his personality.

His reading was limited only in the intellectual sphere by a disposition to avoid the more abstract sciences and, perhaps, in matters of taste by other less important preferences. It included the literature of many languages both ancient and modern and every-

[1] Professor Wheeler was the recipient of many honors. Four universities conferred honorary degrees: Sc.D., University of Chicago (1916); Harvard University (1930); Columbia University (1933); and LL.D., University of California (1928). He received the Elliot Medal of the National Academy and the third Leidy Medal from the Philadelphia Academy of Natural Sciences (1931), and in 1934 was made an Officer in the Legion of Honor. The Royal Entomological Society of London, the Entomological Society of France and the Entomological Society of Belgium also elected him an honorary member. He also belonged to the American Academy of Arts and Sciences, the National Academy of Sciences, the American Philosophical Society and the Zoological Society of France.

thing that he thought possibly of even the smallest interest as an addition to his accumulated store of knowledge and experience. His writing was the expression of his sensitive feeling for style and of his ideal of good workmanship. At its best, for instance, in his occasional satirical pieces, like the letter from the king of the termites and in "The Dry-Rot of Academic Biology," it has a force and a polish, not to mention other qualities, that recall Voltaire.

One can appraise the contributions which an unusual man has made to the civilization of his time. It is almost impossible, however, to convey in words the personality compounded of intellectual and spiritual qualities which characterize the individual as a whole and lend him the flavor and charm that make his death an utterly irreparable loss to his friends. It is quite certain that Wheeler never thought of himself as a great man. In so many ways he was the superior of those about him and his learning and originality were so freely acknowledged that a certain amount of the conceit not uncommon in lesser men might have been excusable. To some extent his sense of humor saved him from this. Like all really great men, he was extraordinarily good company. He laughed with one and, inoffensively, at one; and he was one of the very rare individuals whose idiomatic knowledge of three or four languages was such that he could laugh with equal gusto in all of them. During his later years, he spent most of his evenings in his study in West Cedar Street where one would find him sitting at a deskful of books—with more books on chairs and on the floor and with sheets of manuscript scattered under and over them. The casual visitor was installed in an armchair and the maid sent down for a bottle and the cigars. He had always read some book that other people read later—often at his instigation. His conversation would pick up from this or from some reminiscence that might lead in almost any direction from classical literature to recent discoveries of science. It was difficult to find anything of importance that he had not read—and the scope of his reading ranged from Wilhelm Busch and Alice in Wonderland to Whitehead, who himself regarded Wheeler as one of the greatest men he had ever met. A student has written the following to Mrs. Wheeler: "In a recent lecture, Professor Whitehead characterized him as the only man he had ever known who would have been both worthy and able to sustain a conversation with Aristotle."

A highly developed specialist in his own calling, Wheeler was more completely the intellectual man of the world than any but a very few of his contemporaries in this or any other country. One never left him without having learned something, and one walked down the hill after an evening with him with ever-renewed admiration and affection—and usually with a chuckle.

The death of a great naturalist, like that of a great physician, does more than put an end to a scientific career. It destroys an accumulation and synthesis of knowledge, skill, judgment and experience that can not be transmitted and preserved, because it is as yet incommunicable. To some of Wheeler's friends and colleagues these things seemed the best part of what by devotion, industry, enthusiasm and high intelligence he had made of himself professionally, an achievement even greater than his contributions to science and never to be replaced.

His written contributions to his subject will perpetuate his scientific memory, and his less technical writings will be read with interest and amusement for a long time to come. But as a personality, Wheeler was one of the great experiences in the lives of his friends and, in this sense, he will not really die until all those who knew him well are gone.

L. J. Henderson
Thomas Barbour
F. M. Carpenter
Hans Zinsser

RECENT DEATHS AND MEMORIALS

Frederic Eugene Ives, distinguished for his work on photographic processes, especially on photoengraving and color photography, died on May 27 at the age of eighty-one years.

Dr. L. B. Walton, professor of biology at Kenyon College, Gambier, Ohio, died suddenly on May 15 at the age of sixty-six years.

George Robert McDermott, emeritus professor of structurel design at Cornell University, died on May 26 at the age of seventy-six years.

Professor Ludolf von Krehl, director of the Kaiser Wilhelm Institute for Medical Research, known for his work on the physiology and pathology of the circulatory system, died on May 26 at the age of seventy-six years.

Dr. Alfred Adler, of Vienna, known for his work in psychiatry and psychology, who has been lecturing in England and in the United States, died suddenly on May 29 at the age of sixty-seven years.

A correspondent writes: "Dr. Joseph A. Culler, emeritus professor of physics at Miami University, died on May 18 at the age of seventy-nine years. Graduating from Wooster in 1884, he received the A.M. degree two years later from the same institution and the Ph.D. in 1900. From 1903 to 1927 he was professor of physics at Miami University. Dr. Culler

was a tireless experimenter. A pioneer in the field of x-rays, he lost a considerable portion of one hand before the necessity of caution was known. But this did not long interfere with his experimental work, in which he persisted until a few months ago. He was the author of several texts which were favorably known and several monographs as well. He has for many years served his community in various official capacities. Above all he was loved for his gentle, kindly spirit. His memory will be revered by his colleagues on the faculty and by many thousands of students."

HOMAGE was paid at Media, Pa., on May 13 to the memory of Daniel Garrison Brinton, formerly professor of anthropology at the University of Pennsylvania, on the hundredth anniversary of his birth. Dr. Brinton, a native of Thornbury, near Media, died in 1899. The speakers were George L. Pennock, president of the Delaware County Institute of Science; Dr. Edwin G. Conklin, executive vice-president of the American Philosophical Society; Dr. Clark Wissler, of Yale University and the American Museum of Natural History; Dr. Frank G. Speck, of the University of Pennsylvania, and Burgess W. L. Rhodes, of Media.

A BRONZE plaque has been unveiled in the Chapel of St. Joseph of Arimathaea, Washington, D. C., in tribute to Dr. William Holland Wilmer, professor of ophthalmology in the School of Medicine of Georgetown University, 1906–1925. In 1925 Dr. Wilmer became professor of ophthalmology at the Johns Hopkins University School of Medicine; ophthalmologist-in-chief at the Johns Hopkins Hospital and director of the Wilmer Institute. He retired in 1934 and died on March 12, 1936, when he was seventy-two years old.

SCIENTIFIC EVENTS

THE BIOLOGICAL STATION AT BARENTS SEA

IT is stated in *Nature* that a new biological station is being built by the Academy of Sciences of the U.S.S.R. at Murmansk on the Barents Sea. It is intended for extensive research in morphology, anatomy, embryology, physiology, biochemistry and ecology of sea organisms.

Owing to the penetration of the warm waters of the Atlantic into the Barents Sea, the fauna of the latter is extremely rich and diverse. Of importance is the fact that at Dalnye-Zelenets Bay the water is transparent to a depth of 10 meters and that large stretches of the sea bottom are visible from the surface. The scientific workers at the station will make a detailed study of the problems of evolutionary physiology, embryology and the relationship of the fauna with changed hydrological conditions effected by the Gulf Stream.

The Murmansk biological station will supply biological material to the various research institutes and higher educational institutions of the U.S.S.R. Superintending the building is a special commission consisting of S. A. Zernov (director of the station), L. A. Orbeli, V. I. Vernadsky and N. M. Knipovich, Professor K. M. Deryugin, of the University of Leningrad, Professor L. N. Fedorov, director of the All Union Institute of Experimental Medicine, and Professor I. M. Kreps.

The cost of building the Murmansk Station is estimated at 3½ million roubles, excluding equipment. A scientific library, the zoological, botanical, microbiological and hydrochemical laboratories and the libraries of other departments will be housed in the main building of the station. An aquarium designed for scientific work will be installed on the first floor of this building, while several other aquaria, open to the public, will be erected in the basement of the building. Premises containing students' laboratories will be situated near the central building and will also be equipped with large aquaria. Special interest is attached to an open-air concrete reservoir intended to accommodate large sea animals, including seals.

The spawn of crabs will be brought from the Far East for acclimatization and breeding in the Barents Sea. A special vessel, 30 meters long, built for scientific work in the open sea, will maintain uninterrupted communications between the station and the city of Murmansk.

At the beginning of this year, the Academy of Sciences of the U.S.S.R. commenced extensive work in the Dalnye-Zelenets Bay, east of the Kola Bay (Teriberka district, situated in the Northern Province) for the construction of this biological station, which will be the finest in the Soviet Union. The Soviet architect N. V. Ryumin and his assistants have designed all the buildings.

"VOCABULARY" OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

THE International Electrotechnical Commission planned the publication of the first edition of its international "Vocabulary" early this year. This work, undertaken soon after the St. Louis Electrical Congress in 1904, contains some 2,000 scientific and industrial terms used in the various branches of electrotechnics. It is the result of many years of continuous effort by a committee of experts including delegates from Austria, France, Germany, Great Britain, Italy, the Netherlands, Poland, Spain and the United States.

The work is divided into fourteen sections, the first of which covers fundamental and general definitions. The others more specifically deal with machines and transformers; switchgear and control gears; apparatus for scientific and industrial measurements; generation, transmission, distribution; electrical traction; power applications; thermic applications; lighting; electrochemistry; telegraphy, telephony; radiology; electrobiology. Definitions appear in both English and French, the two official languages of the International Electrotechnical Commission; and a translation of terms alone is given in German, Italian, Spanish and Esperanto. It is expected that translation of the terms into additional languages will be undertaken in future editions.

While the committee developing this "International Vocabulary" appreciates that it does not constitute a complete unification of electrotechnical nomenclature, through periodic review and revision based on the constructive criticism of electricians of the world, it should become increasingly valuable to engineers.

The edition will be limited. Copies can be reserved by writing to the United States National Committee of the International Electrotechnical Commission at 29 West 39th Street, New York, N. Y.

FELLOWSHIPS IN THE SCIENCES AWARDED BY THE JOHN SIMON GUGGENHEIM FOUNDATION

THE following appointments to John Simon Guggenheim Memorial Fellowships for work in the sciences have been announced:

Dr. Willem J. Luyten, assistant professor of astronomy in the University of Minnesota, first granted a fellowship by the foundation in the year 1928: Appointed to continue his study of the stars in the Southern Hemisphere in the neighborhood of the Sun.

Dr. Ronold Wyeth Percival King, assistant professor of physics at Lafayette College: Appointed to make an experimental and theoretical study of the application of the Maxwell field equations to circuit problems at ultrahigh frequencies. This work will be carried on chiefly at the Kaiser-Wilhelm Institute in Berlin-Dahlem, Germany.

Dr. Hans Mueller, associate professor of physics at the Massachusetts Institute of Technology: Appointed to make a study of the structure and properties of liquids, chiefly at the Cavendish Laboratory of the University of Cambridge.

Dr. Lawrence Olin Brockway, research fellow in chemistry at the California Institute of Technology: Appointed to make a determination of the molecular structures of certain heavy metal carbonyls and to give general consideration to the relations between structure and chemical properties, to be carried on, for the most part, in the laboratories of Professor N. V. Sidgwick, at the University of Oxford.

Dr. Florence Barbara Seibert, professor of biochemistry in the Henry Phipps Institute of the University of Pennsylvania: Appointed to make, with the ultracentrifuge, a study of the molecular sizes and cataphoretic mobilities of the active principle of tuberculin in its antigenic and non-antigenic form, to be carried out in the laboratory of Professor The Svedberg at the University of Uppsala.

Dr. James Batcheller Sumner, professor of biological chemistry at Cornell University: Appointed to make, with the ultracentrifuge, a determination of the molecular weights of certain enzymes and crystalline proteins in Professor Svedberg's laboratories.

Dr. Eric Glendenning Ball, associate in psychological chemistry at the Johns Hopkins University: Appointed to conduct a research on the mechanism of biological oxidations. This study will be conducted in several European laboratories.

Dr. William Clouser Boyd, assistant professor of biochemistry in the Boston University School of Medicine: Reappointed to continue studies of blood groups among peoples in southwestern Asia, as data for anthropological investigations.

Dr. William Louis Straus, Jr., associate in anatomy at the Johns Hopkins University: Appointed to make a study of the embryological development of muscle function with particular reference to the anatomical changes that occur in the peripheral neuro-muscular apparatus from physiological immaturity to physiological maturity, to be carried on at the University of London.

Dr. Samuel Robert Means Reynolds, assistant professor of physiology, Long Island College of Medicine: Appointed to work with Dr. George V. Corner, of the University of Rochester, on the nature of the motility-stimulating action of oestrin upon uterine muscle and to prepare a monograph on the physiology of uterine musculature.

Dr. Allan Lyle Grafflin, associate in anatomy at Harvard University: Reappointed to make possible the continuation of functional and cytological studies of the mammalian and human kidney and their extension to other problems pertaining to cellular activity.

Dr. George W. D. Hamlett, research worker in the U. S. Biological Survey at Baltimore: Reappointed to continue a study of the embryology and the reproductive cycles of various South American mammals. Dr. Hamlett is now in Brazil.

Dr. Sydney William Britton, professor of physiology at the University of Virginia: Appointed to establish headquarters at the Barro Colorado Laboratory in the Canal Zone for the purpose of working on the lower forms of mammalia to be found on the Panama Peninsula. His investigations will deal with the functions of the adrenal cortex and the kidney in primitive mammalian forms and in some of the primates.

Dr. Herbert Shapiro, research assistant in physiology at Princeton University: Appointed to investigate nerve activity at low oxygen pressures. These studies will be conducted at the Plymouth and Naples Marine Biological Laboratories.

Dr. Aaron Clement Waters, associate professor of geology at Stanford University: Appointed to make a comparative study of the cataclastic metamorphic rocks, with

a view to ascertaining the condition of their origin, to be conducted in the highlands of Norway and Scotland.

Dr. Charles Henry Behre, Jr., professor of economic geology at Northwestern University: Appointed to make a comparative study of certain lead-zinc deposits, for the purpose of forming generalizations about the nature and structural control of ore deposition in comparison with the lead-zinc ores in limestones in the Mississippi Valley.

Dr. Donald Keith Adams, assistant professor of psychology at Duke University: Appointed to formulate a comprehensive theory of the structure and growth of mind and its testing by application to the data and problems of child psychology.

Dr. Melville J. Herskovits, professor of anthropology, Northwestern University: Appointed to write a book on primitive economics.

SIGMA XI LECTURES AT THE UNIVERSITY OF CALIFORNIA AT LOS ANGELES

THE following public lectures have been given under the auspices of the University of California at Los Angeles Chapter of the Society of the Sigma Xi, in the academic year 1936–37, under the presidency of Dr. George E. F. Sherwood, professor of mathematics:

September 30, 1936: "Periodogram Analysis," by Dr. Dinsmore Alter, director, Griffith Observatory and Planetarium.

October 28: "Sex Determination and Fish Hybrids," by Dr. Albert W. Bellamy, associate professor of zoology, University of California at Los Angeles.

November 4: "The Use of Magnetic Methods in Chemistry," by Dr. Linus Pauling, professor of chemistry, California Institute of Technology.

December 2: "Earthquakes," by Dr. Beno Gutenberg, professor of geophysics and meteorology, California Institute of Technology.

January 6, 1937: "Genes and Hormones in Sex Determination," by Dr. Richard B. Goldschmidt, professor of zoology, University of California, Berkeley.

February 17: "Bright-Line Astronomical Spectra," by Dr. I. S. Bowen, professor of physics, California Institute of Technology.

March 3: "Recent Advances in the Chemotherapy and Serumtherapy of Hemolytic Streptococcal Infections," by Dr. Ralph R. Mellon, director, Institute of Pathology, Western Pennsylvania Hospital.

March 10: "Studies in Language Disabilities," by Dr. Grace M. Fernald, associate professor of psychology, University of California at Los Angeles.

March 19: "Transmutations of Atomic Nuclei," by Dr. Niels Bohr, professor of physics, University of Copenhagen, and Hitchcock Lecturer, University of California, Berkeley, 1936–37.

March 24: "Plant Growth in Relation to Minute Amounts of Certain Chemical Elements," by Professor Dennis R. Hoagland, professor of plant nutrition, University of California, Berkeley.

April 7: "Visitors from Cosmic Space," by Dr. Frederick C. Leonard, chairman, department of astronomy, University of California at Los Angeles.

May 5: "Some Aspects of the Cosmic-Ray Problem," by Dr. Carl D. Anderson, assistant professor of physics, California Institute of Technology.

May 7: "Did Man Originate in Africa?," by Dr. Robert Broom, South African biologist and paleontologist.

SYMPOSIUM ON THE STRUCTURE OF METALLIC PHASES

A SYMPOSIUM on the structure of metallic phases has been arranged by the department of physics at Cornell University for July 1, 2 and 3. The address of welcome will be made by the president of the university, Dr. Edmund E. Day.

The symposium will deal primarily with the "cooperative phenomena" in solids. The factors determining the stability of phases will be discussed from the standpoint of thermodynamics by Dr. J. C. Slater, of the Massachusetts Institute of Technology; statistics by Dr. J. G. Kirkwood, of Cornell University, and by Dr. F. Bitter, of the Massachusetts Institute of Technology, and the quantum theory by Dr. F. Seitz, of the University of Rochester.

The phenomena which will receive special attention are the changes of structure and ferromagnetism. The first topic is divided under two headings, phase changes of the first kind, characterized by the existence of a latent heat, and those of the second kind, for which there is only a jump of the specific heat at the transformation temperature. The most commonly known phase changes, melting and allotropic transformations, are of the first kind; the experimental material will be presented by Dr. E. R. Jette, of Columbia University. The formation of superlattices, to be discussed by Dr. F. C. Nix, of the Bell Telephone Laboratories, involves generally a phase change of the second kind. In all cases, the speed of the transformation has an important bearing upon its occurrence or non-occurrence, which is seen by the often large effect of annealing, and by phenomena such as the aging of alloys which show that statistical equilibrium is frequently attained only after a very long time. Dr. R. F. Mehl, of the Carnegie Institute of Technology, will discuss these questions and their relation to the diffusion in solids. The relation of ferromagnetism to the general theory of cooperative phenomena will be discussed by Dr. Bitter, who will also show how the ferromagnetic properties of alloys can be correlated with those of the pure metals. The relation of ferromagnetism to the crystal structure and especially the dependence of the magnetization on the direction relative to the crystal axes will be discussed by Dr. L. W. McKeehan, of Yale University, and by Dr. R. M. Bozorth, of the Bell Telephone Laboratories.

An effort is being made to correlate the various reports so that those not familiar with the field may gain a clear understanding of the topics discussed.

The last morning will be devoted to a general coordination and summary of all the papers presented, with Dr. Slater leading the discussion.

The program has been arranged so as to provide ample time for discussion periods both formal and informal. Opportunity for social gatherings will be available. Arrangements will be made for housing those in attendance, including families, in one of the university dormitories for the nights of June 30, July 1 and 2. There will be a registration fee of one dollar for those attending the meetings of the symposium. Further information can be obtained by addressing Dr. R. C. Gibbs, Rockefeller Hall, Ithaca, N. Y.

IN HONOR OF DR. L. O. HOWARD

THE eightieth birthday of Dr. L. O. Howard, which occurs on June 11, was celebrated by Washington entomologists on May 27. Dr. F. C. Bishopp, entomologist of the Bureau of Entomology and Plant Quarantine, and Dr. W. R. Walton, senior entomologist, read a biographical sketch. Other speakers included Dr. Lee A. Strong, chief of the bureau; A. L. Quaintance, formerly assistant chief; A. D. Hopkins, formerly chief of the Forest Insect Division, and N. E. McAdoo, president of the Entomological Society of Washington.

Dr. Howard became chief of the Bureau of Entomology in 1894, having been connected with it since his graduation from Cornell University in 1877. He was head of the bureau until his retirement in 1927, and for four years longer was principal entomologist. He was permanent secretary of the American Association for the Advancement of Science from 1898 to 1919, and president of the association in 1920. In reference to Dr. Howard's scientific work a correspondent writes:

As early as 1888, Dr. Howard achieved international renown because of his notable studies of parasitic hymenoptera (wasp-like insects). Subsequently, insect parasites have been used as an important means of controlling insect pests.

Dr. Howard is famous also for his studies of mosquitoes, which began in 1892, several years before the discovery that mosquitoes transmit malaria, yellow fever and other diseases. When certain mosquito species were identified as disease carriers, Dr. Howard was ready to recommend control measures, particularly the use of kerosene.

The common housefly also attracted Dr. Howard's attention in the field of medical entomology. His book, "The Housefly—Disease Carrier," published in 1911, is largely responsible for the world crusade against the housefly during the last 25 years.

His recommendations for boll-weevil eradication, if followed when this insect was first discovered in Texas, would have saved the South millions of dollars later. In New England, the gipsy moth campaign; in the East Central States, the corn borer control operations, and along the Atlantic Coast, the Japanese beetle warfare, are but a few examples of the efforts to eradicate insect pests which began while Dr. Howard was chief of the Bureau of Entomology.

He wrote a book in 1931 called "The Insect Menace," which awakened wide-spread interest in the dramatic warfare that exists between mankind and the insect world. While optimistic as to the ultimate ability of human beings to retain supremacy over their insect enemies, Dr. Howard in this book focused attention on the need for ever-vigilant measures and a sufficient force of trained entomologists to maintain the continual large-scale control operations necessitated by change in agricultural practices.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM PRATT GRAHAM, professor of electrical engineering, dean of the College of Applied Science and vice-chancellor of Syracuse University, was elected chancellor on May 29. He had been acting chancellor since the resignation last July of Chancellor Charles Wesley Flint, who is now a bishop of the Methodist Episcopal Church in Atlanta.

AT an informal meeting of the Division of Geological Sciences of Harvard University, on May 24, a collection of studies in mineralogy was presented to Professor Charles Palache as a token of personal regard and an appreciation of his outstanding and still-continuing service to mineralogy. The presentation volume, which forms the current issue of the *American Mineralogist*, contains thirty-five papers by American and European mineralogists and a list of Professor Palache's writings. The short speeches of congratulation emphasized Dr. Palache's eminence as investigator and teacher, collector and curator, and his constant encouragement to every form of mineralogical study.

A GOOD-WILL dinner in honor of Dr. Rodney H. True, who becomes professor emeritus at the close of the academic year, was given by members of the department of botany of the University of Pennsylvania on the evening of May 21 at the Valley Green Inn, near Chestnut Hill. Those present were Dr. H. Lamar Crosby, dean of the Graduate School, and Dr. Paul H. Musser, dean of the College of Arts and Sciences, as guests, and Drs. D. Walter Steckbeck, Irwin Boeshore, William Seifriz, John M. Fogg, Harlan H. York, Conway Zirkle, Edgar T. Wherry, Wesley G. Hutchinson and John K. Edwards.

IN recognition of his completion of twenty-five years of teaching service in food and colloid chemistry at

Columbia University, the former and present doctoral research students of Professor Arthur W. Thomas gave him and Mrs. Thomas a surprise dinner party at the Columbia University Faculty Club on May 22. He was presented with a cap, gown and academic hood in token of their esteem.

DR. WILMER KRUSEN, president of the Philadelphia College of Pharmacy and Science, was the guest of honor at a dinner given for him on May 26 by the alumni association. Dr. Krusen has been president of the college since 1927. For eight years he was director of public health of Philadelphia.

THE University of Pennsylvania on June 9 will confer its doctorate of science on Dr. Florence Rena Sabin, member of the Rockefeller Institute for Medical Research, and on Dr. Lightner Witmer, professor of psychology and founder of the psychological clinic at the university.

THE Michigan College of Mines and Technology at the annual class-day ceremonies on June 4 will confer the degree of doctor of science on Dr. Alexander G. Ruthven, president of the University of Michigan, formerly professor of zoology. The degree of doctor of engineering will be conferred on William L. Honnold, mining engineer, chief aid to Mr. Hoover in Belgium during the war. Dr. Ruthven will be the principal speaker.

THE Holley Medal of the American Society of Mechanical Engineers was presented to Henry Ford at a banquet given on May 20 during the annual convention of the society in Detroit.

ELLIS LOVEJOY, Columbus, research director for the Edward Orton Ceramic Foundation, and Edgar C. Bain, New York City, assistant to the vice-president of the U. S. Steel Corporation, have been awarded by the Ohio State University Benjamin G. Lamme Medals for outstanding achievement in engineering.

THE annual award of the Cyrus Hall McCormick Gold Medal of the American Society of Agricultural Engineers for "outstanding achievement in agricultural engineering" has been made to Professor Chester O. Reed, of the Ohio State University. The presentation will be made at the annual meeting of the society at the University of Illinois.

OFFICERS of the Geological Society of America have been nominated by the council as follows: *President*, Arthur L. Day, Washington, D. C.; *Past President*, Charles Palache, Cambridge, Mass.; *Vice-presidents*, T. Wayland Vaughan, Washington, D. C.; Warren J. Mead, Cambridge, Mass.; Joseph A. Cushman, Sharon, Mass.; N. L. Bowen, Washington, D. C.; *Secretary*, Charles P. Berkey, New York, N. Y.; *Treasurer*, Edward B. Mathews, Baltimore, Md. Additional councilors nominated are: Morley E. Wilson, Ottawa, 1938; John B. Reeside, Jr., Washington, D. C.; Henry A. Buehler, Rolla, Mo., and Elias H. Sellards, Austin, Texas, 1938–1940. Stephen R. Capps, Washington, D. C., was nominated representative on the National Research Council from July 1, 1938, to June 30, 1941.

PROFESSOR C. H. BEST, of the University of Toronto, was elected on May 25 president of the Canadian Physiological Society at its third annual meeting, which was held in London, Ontario. Professor G. H. Ettinger, of Queen's University, Kingston, was named secretary, and Professor E. M. Watson, of the University of Western Ontario, London, treasurer. Councillors elected were: Antonio Barbeau, Montreal University; Romeo Blanchett, Laval University; J. B. Collip, McGill University; George Hunter, University of Alberta; H. Wasteneys, University of Toronto, and E. G. Young, Dalhousie University.

IRVING G. REIMANN, curator of geology at the Buffalo Museum of Science, was elected president of the New York State Geological Association, and Professor William P. Alexander, assistant curator of education in charge of adult activities, was made secretary, at the annual meeting held in Syracuse, N. Y., on May 8 and 9. The association will hold its annual meeting in 1938 at Buffalo with trips to Eighteen-Mile Creek and Niagara Gorge.

DR. NORMAN L. BOWEN, petrologist at the Geophysical Laboratory of the Carnegie Institution of Washington, D. C., has been appointed first Charles L. Hutchinson distinguished service professor in the department of geology of the University of Chicago. Professor Bowen will succeed Dr. Albert Johannsen, who has reached the age of retirement after having served for twenty-eight years as professor of petrology. The Charles L. Hutchinson professorship has been established by the Board of Trustees in recognition of the interest taken by the late Mr. Hutchinson in the university, of which he was for many years a trustee and treasurer, and of Mrs. Frances K. Hutchinson.

DR. P. H. EMMETT, who since 1926 has been engaged in research at the Fixed Nitrogen Research Laboratory at the U. S. Department of Agriculture, Washington, has been appointed to the chair of chemical and gas engineering in the School of Engineering of the Johns Hopkins University. He succeeds Dr. Wilbert J. Huff, who resigned recently.

DR. CHARLES W. BALLARD, professor of materia medica in the College of Pharmacy, Columbia University, has been named acting dean of the college to take the place of Dean Henry V. Arny, whose retirement becomes effective on July 1.

DR. L. H. TIFFANY, professor of botany at the Ohio State University, has been appointed chairman of the department of botany at Northwestern University.

THE Morris Arboretum of the University of Pennsylvania has appointed F. R. Fosberg, of the department of botany of the University of Hawaii, to a Morris Arboretum fellowship for the coming school year. Mr. Fosberg will carry on his investigations at the arboretum and at the department of botany of the University of Pennsylvania.

DR. WILLIAM R. FOOTE, of the New Haven Hospital, has been awarded the William Harvey Cushing memorial fellowship at Yale University.

Nature prints a list of professors who have left Germany on account of the political situation who are working at the University of Istanbul. Among these are: Professor H. Winsterstein, physiology; Professor M. Brauner, botany; Professor M. Dember, physicist; Professor M. von Mieses, mathematics, and nearly thirty others, most of whom have been appointed to chairs. Professor M. Freundlich, who is at present professor of astronomy, leaves at the end of the academic year for the University of Prague, and Professor F. Dessauer, professor of röntgenology, is going to the University of Fribourg, Switzerland.

DR. IRVIN STEWART, vice-chairman of the Federal Communications Division, has been appointed chairman of a Committee on Scientific Aids to Learning, appointed by the National Research Council. The official announcement states that "the purpose of the committee is to canvass, and to report to the council, the extent to which and the means by which certain methods, data, materials and products of science are and may be applied to learning." Members of the committee include: Dr. James B. Conant, president of Harvard University, *chairman;* Vannevar Bush, dean of the School of Engineering, Massachusetts Institute of Technology; L. D. Coffman, president of the University of Minnesota; Frank B. Jewett, president of the Bell Telephone Laboratories; Ben D. Wood, associate professor of collegiate educational research, Teachers College, Columbia University; Bethuel M. Webster, of New York, *secretary,* and Ludvig Hektoen, chairman of the National Research Council, member *ex-officio.*

MEMBERS of the Consulting Board of Cancer Research of Columbia University have been appointed as follows: Dr. Thomas Hunt Morgan, of the California Institute of Technology; Dr. William J. Mayo, of the Mayo Clinic, Rochester, Minn.; Dr. George H. Semken, consulting surgeon at Knickerbocker Hospital and the Presbyterian Medical Center; Dr. Paul M. Giesy, professor of chemistry at Newark College of Engineering; Professor Ernest O. Lawrence, of the University of California; and the following members of the faculty of Columbia University: Dr. George B. Pegram, Dr. Edmund B. Wilson, Dr. Gary N. Calkins, Dr. Henry C. Sherman, Dr. Marston T. Bogert, Dr. Bergen Davis and Dr. Eugene H. Pool.

DR. GEORGE W. MCCOY, honorary vice-president of the American Mission to Lepers and for twenty-one years director of the National Institute of Health, will make a study of the leprosy problem in the United States and island possessions for the United States Public Health Service.

DR. F. F. MCKENZIE, cooperative investigator for the University of Missouri in the U. S. Department of Agriculture, has leave of absence. He expects to sail for Europe on July 31 to act as investigator for the department in Norway, Sweden, Denmark, Belgium, France and England.

A PALEONTOLOGICAL expedition, which will spend several months collecting fossil vertebrates in Colorado for the Field Museum of Natural History, left Chicago on May 15. The first members of the party to leave were Bryan Patterson, assistant curator of paleontology, and James H. Quinn, assistant. Elmer S. Riggs, curator of paleontology, will join them a few weeks hence.

FRANK TOSE, chief of exhibits in the California Academy of Sciences, San Francisco, has been selected by the Carnegie Corporation of New York to represent it on a trip to Australia and New Zealand for the purpose of introducing there the latest methods of preparation of natural history habitat groups in the public museums. Mr. Tose has been given leave of absence by the academy for eight months, and will sail for Sydney on June 22.

DR. LEE R. DICE, retiring president of the Michigan Academy of Science and director of the laboratory of vertebrate genetics at the University of Michigan, was guest at a special convocation held for major students and staff members of the Wayne University department of biology. Dr. Dice described a technicolor film on the "Variation in Color and Behavior in Mice, with Special Reference to Those of a Genetic Nature."

DR. CARL GUSTAV JUNG, professor of analytic psychology at the Federal Polytechnical University at Zurich, Switzerland, has been appointed Dwight H. Terry lecturer for 1937–38 at Yale University. He will deliver the lectures next October.

DR. EDMUND V. COWDRY, of Washington University, St. Louis, delivered the annual address of the Kappa Chapter of Phi Sigma Society at the Univer-

sity of Kansas on May 13. His subject was "How Living Cells Manage Their Social Problems."

DR. J. S. L. BROWNE, of the Royal Victoria Hospital, Montreal, on April 26 lectured to the students and staff of the hospital of Duke University on "Studies of Sex Endocrine Physiology of the Female," and on May 3 Dr. David M. Davis, professor of urology at Jefferson Medical College, Philadelphia, lectured on "Chronic Prostatitis."

A CHAPTER of Sigma Xi was installed at the Oregon State College in May, with Dr. W. F. Durand, of Stanford University, national president of the society, acting as installing officer. Seventy-six faculty men and women became charter members. An all-school convocation, called to honor the Sigma Xi chapter, was addressed by Dr. Durand. His subject was "Power and Civilization." The installation ceremony was followed by a banquet, at which Dr. Linus Pauling, an alumnus of the college, and now head of the chemistry division of the California Institute of Technology, was the principal speaker. He spoke on "Hemoglobin and Magnetism." Dr. W. E. Milne, professor of mathematics, was toastmaster for the banquet, and Dr. F. M. Hunter, chancellor of the Oregon System of Higher Education, was a guest. Officers elected by the chapter are: F. O. McMillan, *president;* Dr. Don C. Mote, *vice-president;* W. E. Lawrence, *secretary,* and Dr. D. E. Bullis, *treasurer.*

THE program for the Symposium on Colloid Chemistry to be given at the University of Minnesota, Minneapolis, Minn., on June 10 and 11, and at Rochester, Minn., on June 12 has been completed and is being printed for distribution. Twenty-two papers will be presented at the University of Minnesota on June 10 and 11, and eight papers will be given at Plummer Hall of the Mayo Foundation at Rochester, Minn., on June 12. Professor Herbert Freundlich, of University College, London, will open the sessions at Minneapolis as well as those at Rochester. Dorothy Jordon Lloyd, of the British Leather Manufacturers' Research Association, will give the second paper at the first meeting of the symposium. The program of the first day will be largely devoted to problems related to bio-colloids, while the papers of the second day will concern themselves with subjects of general interest to colloid chemists. The meeting at Rochester will be of principal interest to those concerned with the colloid problems of physiology and medicine. While at the Mayo Clinic an opportunity will be offered to visit the laboratories and to learn something of the researches in progress.

DISCUSSION

THE VOLUME OF ENTOMOLOGICAL LITERATURE

WITHOUT meaning to suggest that research in entomology should be in the least abated, it seems timely to direct attention to the volume of literature already published concerning insects. What will be said here about entomological matter doubtlessly applies equally to other aspects of biological science. The *Zoological Record* and the *Review of Applied Entomology* were the sources of the data concerning the number of articles discussed below. Through the kindness of Dr. S. A. Neave and W. L. Sclater, who direct the preparation of these two aids, it was learned that their contents are not duplicated to exceed 10 per cent. On this basis, the number of separate entomological items published between 1913 and 1934, for which period both *Record* and *Review* are available, was not less than 100,935, or an average of 4,588 per year. Adding to this figure the titles cited in the *Record* alone for the years 1864 to 1912, the period preceding the advent of the *Review,* we have a total of about 175,000 articles and books, with an average yearly output for the 70 years from 1864 to 1934 of about 2,500 separately published items.

To this total should be added several hundred articles listed in the several volumes of the International Catalogue of Scientific Literature for 1904 and 1905 that seem not to have been included in the *Zoological Records* for those years. The final total of papers and books already put out by our force of workers is therefore truly overwhelming.

It is true that a considerable body of the published matter, and in particular that of the earlier years, has been absorbed in later publications dealing with the same subjects. Progressive digests have been provided in an inadequate number of revisional taxonomic papers, in bulletins concerning important harmful species, in books on economic entomology and in general texts. Most entomological books are designed largely for classwork. While these books contain useful digests, they do not presume to exhaust the accumulated knowledge concerning the species or features treated. On the other hand, there is a phase of insect literature which has not received even the abridged treatment accorded the outstanding economic species, and has suffered almost complete neglect from book writers. Reference is made here to the field of insect bionomics, with particular reference to the habits and developments of groups not primarily economic. Many thousands of published articles pertaining more or less to the bionomics of scavengers, weed-eaters, predators

and parasites of other insects and a host of forms now rated as secondary or potential pests have not been summarized in bulletin or book form for the use of student and professional entomologists. The publication of mountains of literature avails little for the increase of knowledge so long as the facts remain buried and scattered in the numerous serial publications and the diverse languages of the whole scientific world. It is obviously impossible for student or professor to assemble the data from so large a number of papers, and as a consequence many salient facts are never discovered and are never acquired for our use.

The abstract journals perform a very valuable service in providing the essence of individual articles, many of which would otherwise remain out of reach of most entomologists, owing to their distant origin and foreign language difficulties. But such abstracts are largely concerned with economic species or aspects, and moreover leave the subject-matter unassembled and uncorrelated and therefore still oblige the student or worker to expend much time in bringing it together. The usual result of this necessity is that the data remain unacquired by them. The writer believes, in the face of the mountainous mass of published matter, that entomology should encourage the preparation of occasional summary studies of its literature. These would be concerned either with species or aspects for which a considerable number of bionomic papers have already appeared but whose essence has not been assembled, organized, condensed and republished in the form of source books or comprehensive bulletins for the use of the entire profession. Needed are the services of a number of workers who have the facilities of a good library at their disposal, who enjoy some freedom from other duties, and are willing to forego research for a period of years to accomplish this task for the common welfare. The result would probably be more effective for the advancement of the science of entomology than an equivalent amount of time and energy devoted to the production of original papers. Dr. Schedl's comprehensive summary paper on the gipsy moth, a review of which appears in the *Journal of Economic Entomology* for April, 1937, exemplifies the type of species study to which reference is here made. The broader type of summary paper may, for example, deal with the bionomics of a group such as the scavengerous insects, the several phytophagous groups of the different orders, or the mammalicolous and avicolous parasites. It is true that the taxonomic muddles existing in many families and other categories of insects hinder studies of this type. Moreover, it is fully realized that many gaps exist in our knowledge of the habits of 90 per cent. or more of the insects, but these conditions do not warrant us in withholding the many already available salient facts from the reach of our students and professional men for the several more centuries necessary to develop knowledge to a state of completeness. Moreover, no one will deny that summaries of knowledge, be it ever so fragmentary, are not only instructive to students but serve to point out open areas in which research needs to be done and also afford an impetus to such investigations. What entomology wishes eventually to accomplish is the conversion of detailed facts into general principles or natural laws. These laws will not become established abruptly in a far-off day but take shape gradually as facts supplant the many black spaces of ignorance that still exist in entomological knowledge. Occasional summaries of the sort advocated herein will do more than any other single device toward the revelation of these natural laws in the insect class.

Persons who have attempted to prepare summaries of entomological literature of the types described above encounter bibliographical difficulties which more or less seriously interfere with their desire to make their work thoroughly complete. When hundreds or thousands of titles concerning the subject in hand have been assembled and their essence extracted and finally prepared in organized form for publication, no small number of omissions will be discovered sooner or later. In making selections of articles for his bibliography, the summarizer can judge what pertains to his subject only by the titles of articles listed in bibliographical aids. But numerous essential data are published in papers whose titles do not, and can not, give any hint concerning the inclusion of pertinent facts. As a result these data are overlooked and remain unincorporated in books, and in some instances will long, if not forever, remain buried in the mass of promiscuous publications. This situation does not exist so far as the literature of economic entomology for the years from 1913 to date is concerned, since it is quite adequately placed within reach of all by the complete classified indices of the *Review of Applied Entomology*. Even this excellent work would be made more useful by the addition to its index of such inclusive divisions as phytophagous, parasitic, predacious, scavengerous and references to other food habits of insects. Owing to the tremendous number of species comprehended by entomology, no one can remember to what food groups all the species belong; hence the summarizer is obliged to rely to some degree on the bibliography or abstract journal for such facts.

But the difficulties attending efforts to summarize all essential facts are particularly great in the literature for the years preceding 1913, previous to the advent of the *Review*. Yet they are no less so for all time in the groups which have only minor economic importance but still hold much interest for the bionomist. This situation seems to call for an extension of the

Review plan of indexing and abstracting to include (1) the species that now have only bionomic value and (2) the entire literature published before 1913, the year in which the *Review* began its appearance.

W. V. BALDUF

UNIVERSITY OF ILLINOIS

SELECTION OF FOOD BY THE CILIATE CHILODON

THE work of Schaeffer[1] indicates that amoeboid protozoa are capable of selecting their food. The same investigator[2] also found that such was the case with the flagellate, *Jenningsia diatomophaga*. However, as stated by Bragg[3] (p. 433), "the ability of a ciliated protozoon to select its food is still open to question." From his own observations, Bragg concludes (p. 441) "that *Paramecium trichium* has a limited ability to select its food, (but) that the individuals vary in the amount of selective action which they show. . . ." Calkins,[4] on the other hand, doubts that the continuously feeding *Paramecium* is capable of exercising any selection.

A pertinent observation in this regard was made by the writer upon the feeding habits of an unidentified species of *Chilodon* (continuous feeder). In water which had been fertilized with 0.45 gram of fish meal per liter, and which contained, in numbers per cubic centimeter, 5,152,000 cells of *Scenedesmus*, 124,000 cells of *Chlamydomonas* and 1,900 *Chilodon*, it was found that the ciliates had gorged themselves upon *Chlamydomonas*. Very few individuals, however, were found to have ingested *Scenedesmus*, and then only sparingly, although these algae were present in much greater numbers. Thus, it would appear that, under these conditions at least, *Chilodon* is definitely capable of selecting its food. The degree of selection was greater than that observed by Bragg for *Paramecium*, although, as indicated by that author, individuals varied in the selective action exhibited.

M. W. SMITH

ATLANTIC BIOLOGICAL STATION,
ST. ANDREWS, N. B.

THE CHEMICAL ATOMIC WEIGHT OF CARBON

IN the 1937 report[1] of the International Committee on Atomic Weights, the chemical atomic weight of carbon was raised from 12.00 to 12.01. This change was made on the basis of the precision combustions of hydrocarbons by Baxter and Hale,[2] whose result confirmed the higher value indicated by gas density and mass spectrographic evidence. In view of the present interest in the atomic weight of carbon it has seemed advisable to make a preliminary report on a determination of atomic weight of this element by the analysis of benzoyl chloride according to the classical method of titration with silver. So far as we can determine, this is the first time acyl halides have been used for this purpose.

Benzoyl chloride was prepared from purified benzoic acid and phosphorus trichloride. The first of these substances was obtained by the oxidation of toluene with alkaline permanganate and was purified by crystallization from water, and finally by sublimation. Phosphorus trichloride was twice distilled in vacuum in an all glass apparatus and the middle fraction was taken for the preparation. The benzoyl chloride was purified by repeated fractionation in evacuated apparatus constructed entirely of pyrex glass. Samples for analysis, weighing approximately 14 g, were collected in small glass bulbs.

For analysis the carefully weighed sample bulb was broken under a 50 per cent. aqueous solution of pyridine under which conditions rapid hydrolysis of the benzoyl chloride occurred. After the collection of the glass fragments in the usual way, the solution was acidified with nitric acid, and the chloride balanced with pure silver. The endpoint was determined nephelometrically.

The analyses of five samples, covering eight distillations, have yielded a value for the atomic weight of carbon very close to 12.010. Since these samples represent the extreme fractions, it seems unlikely that the final value will deviate greatly from this figure.

ARTHUR F. SCOTT
FRANK H. HURLEY, JR.

THE RICE INSTITUTE

THE PUBLICATION OF TROLAND'S PSYCHOPHYSIOLOGY

THE fourth volume of the series of the late Professor Leonard Troland (Harvard University) covering psychophysiology remains unpublished because the publishers of the earlier volumes feel that they should have a guarantee of about $2,500, to be repaid from sales. One of Professor Troland's colleagues has expressed willingness to put the manuscript into shape for publication, and said: "Troland considered this final volume the final and best statement of his views. None of Troland's other books have been subsidized, and most of them have made money, but I can appreciate the (publisher's) attitude towards the fourth volume in a period like the last three or four years—a

[1] Asa A. Schaeffer, *Trans. Tenn. Acad. Sci.*, 1912–13, p. 59; *idem.*, *Jour. Exp. Zool.*, 20: 529, 1916; *idem.*, *Jour. Animal Behavior*, 7: 220, 1917.

[2] *Idem.*, *Trans. Amer. Micros. Soc.*, 37: 177, 1915.

[3] Arthur N. Bragg, *Physiol. Zool.*, 9: 433, 1936.

[4] G. N. Calkins, "The Biology of the Protozoa," p. 607. Philadelphia, 1933.

[1] *Jour. Am. Chem. Soc.*, 59: 219, 1937.

[2] *Jour. Am. Chem. Soc.*, 58: 510, 1936; 59: 506, 1937.

period of uncertainty for the publishers of anything, even best-selling novels."

Since the National Research Council, so I understand, is the residuary legatee of the Troland estate, perhaps you may be willing to publish this note by way of an appeal to any interested person or organization that is in position to make the guarantee, and thus render a service to science. Unless something is done promptly, the book may be lost.

JEROME ALEXANDER

50 EAST 41ST STREET
N. Y. CITY

SCIENTIFIC BOOKS

COLORIMETRY

Handbook of Colorimetry. Prepared by the Staff of the Color Measurement Laboratory, Massachusetts Institute of Technology, under the Direction of Arthur C. Hardy. Pp. 87, Figs. 30, Charts 23. The Technology Press, Mass. Inst. of Tech., Cambridge, Mass., 1936. Price $5.00.

THIS publication contains a detailed description of the method of computing certain colorimetric quantities from spectrophotometric data, together with elaborate tables and graphs greatly facilitating the computations. Its scope can best be indicated by listing the chapter headings and giving a brief abstract of the most important features of each chapter.

(1) *The Physical Basis of Color Specification.* The material in this chapter is general, introducing the reader to the idea of spectrophotometric analysis and giving him a brief preview of the rest of the book.

(2) *Sources of Light.* This chapter discusses the types of illuminants under which samples are ordinarily viewed, such as incandescent illuminants of various color temperatures and the various phases of daylight. Special attention is properly devoted to the three illuminants recommended for colorimetric use by the International Commission on Illumination and known as I. C. I. illuminants A, B and C. Illuminant A is a Planckian radiator or black body, in practice a gas-filled tungsten lamp, operating at a specified color temperature; illuminant B is a combination of illuminant A with a specified light filter yielding a chromaticity and relative energy distribution (in the visible spectrum) approximating those of average noon sunlight; illuminant C is a combination of illuminant A with a filter yielding an approximation to average daylight. Tables are given of the relative energy distribution of each of these three illuminants, values being given at each millimicron from 380 to 780 mμ. Relative energy values are also given at every 10 mμ from 360 to 750 mμ for sunlight above the atmosphere and for average Washington noon sunlight.

(3) *Spectrophotometry.* The effect on the spectral transmission of changing the thickness of a transparent material and the concentration of a transparent solution is discussed and illustrated. The subjects of specular and diffuse transmission and reflection are briefly considered. One statement in this chapter should not be overlooked—". . . it is obvious that every color specification must be accompanied by a complete statement of the geometry of the illuminating beam and the geometry of that portion of the reflected (or transmitted) beam that is evaluated in the measurement."

(4) *The Laws of Color Mixture.* The subtractive and additive methods of mixture are briefly discussed and illustrated. A table of wave-lengths of complementary lights is given; when these lights are mixed together additively in pairs in the proper amounts, they will yield the chromaticity of I. C. I. illuminant C.

(5) *Determination of Tristimulus Values by the Weighted Ordinate Method.* Data are given and the procedure is outlined for computing from a table of spectrophotometric data the amounts of the three hypothetical I. C. I. primaries which the I. C. I. standard observer would require in additive mixture to match the color in question. The three numbers thus computed serve as a fundamental definition of the color of the sample for the specified conditions of illumination and observation used in obtaining the spectrophotometric data. Tables of the tristimulus values for the spectrum of an equal-energy stimulus and for the spectra of illuminants A, B and C, respectively, are given at each millimicron from 380 mμ to 770 mμ (to 740 mμ only for illuminant C).

(6) *Determination of Tristimulus Values by the Selected Ordinate Method.* In this alternative method of deriving tristimulus values the numerous multiplications necessary by the weighted ordinate method are eliminated and the computational labor is reduced to a determination of values of the spectral transmission or reflection quantities at the selected ordinates followed by a simple adding of the numbers so selected. Tables of 30 and 100 selected ordinates for each tristimulus distribution are given for illuminants A, B and C.

(7) *Trichromatic Coefficients.* The respective ratios of each of the tristimulus values to their sum are defined as the trichromatic coefficients (trichromatic coordinates, trilinear coordinates). These coefficients serve to specify the chromaticity of the color. Trichromatic coefficients on the I. C. I. basis are given for a few selected illuminants, and for the spectrum at each millimicron from 380 to 780 mμ.

(8) *Graphical Representation of Colorimetric Data.* This final chapter contains 25 charts, in which the coordinates are the trichromatic coefficients, x and y, on the I. C. I. basis, and on which are plotted lines at suitable intervals to enable one to read values of dominant wave-length and excitation purity for the I. C. I. standard observer and with illuminant C as the reference point from which the dominant wave-length loci diverge. Formulas are given for the inter-conversion of excitation purity and colorimetric purity. These charts are called "chromaticity diagrams," but it should be remembered in any use of such charts that the I. C. I. coordinate system is such that equal distances in various directions, or in the same direction on various parts of the complete diagram, do not indicate equal chromaticity intervals. The lack of proportionality is often many-fold.

It is well known to experts in colorimetry that the colorimetric method described in this book—*viz.*, spectrophotometry accompanied by colorimetric computations based on data fairly representative of an average normal observer—is the most analytical and fundamental which it is possible to use. As such, it is extremely valuable for record and specification purposes. It enables a control to be placed on master color standards otherwise impossible. Of course, there are various types of work where the spectrophotometric data are sufficient in themselves for the purpose. For such, the Handbook would be of little use. But for those who wish to convert such data to colorimetric terms, so that differences in spectrophotometric data may be understood and expressed colorimetrically, the Handbook is of considerable value. It supplements the work of Judd[1] by enabling dominant wave-lengths and purities to be derived graphically instead of algebraically, although the solution is restricted to illuminant C used both as illuminant and reference point.

In addition to the graphs, the parts of the book which are essentially new are the one-millimicron interpolations of the various functions and the wave-lengths of the selected ordinates. These data are undoubtedly of high accuracy and should be of permanent value, particularly to those wishing to make transformations from the International Commission on Illumination coordinate system to other coordinate systems. However, the usefulness of this work does not depend solely on the amount of new material in it, but on the fact that it contains an exposition of the method and a compilation of data brought together in one volume from diverse sources.

In addition to summarizing what may be found in the "Handbook of Colorimetry," it is equally important to indicate those possibly pertinent things which will not be found in it, things which were obviously outside the purpose of the authors in producing such a work, but which those interested in the subject might expect to find included. One might feel handicapped by the lack of references. One must look elsewhere for a thorough discussion of the controversial subject of the definition of color. Psychometric methods applied to color are not considered. There is no discussion of specific systems of material color standards—color cards, atlases, dictionaries, etc.—and but little about colorimeters or filter photometers, visual or photoelectric.

The chapter on spectrophotometry deals with the quantities measured rather than with the methods of measurement. In the discussion of reflection measurements, however, the distinction between *reflectance* and *apparent reflectance* is not brought out. This distinction is particularly important in the colorimetry of glossy materials, where it is usually desirable to exclude the specular component of the reflected light. The International Commission on Illumination, at the same time that it recommended the use of data defining the standard observer and coordinate system and illuminants A, B and C, also recommended that in the colorimetry of opaque materials, except for special cases, the sample be illuminated unidirectionally at 45° and the reflected light be taken for measurement in a direction normal to the surface. This 45°-normal condition of illumination and observation, or some other condition eliminating the specular component of the reflected light from the measurements, must be used if the colors of glossy materials are to be properly specified. The Handbook ignores this I. C. I. recommendation.

One might differ with the authors on various other matters of definition and emphasis and on certain minor details, but to raise these questions here would detract attention from the main purpose of this review, which is to indicate in brief space the nature and scope of the information to be found in the book. The title appears too broad in that there are many phases of colorimetry not included. However, the authors are to be heartily commended for the emphasis which this work places on the most fundamental of all colorimetric methods. In view of the recent improvements in recording spectrophotometers, to which Professor Hardy has so largely contributed, it becomes of increasing importance that methods of colorimetric computation be speeded up to keep pace. To this end the Handbook is another step forward in the science and practice of colorimetry.

KASSON S. GIBSON
NATIONAL BUREAU OF STANDARDS

[1] The 1931 I. C. I. standard observer and coordinate system for Colorimetry, *Jour. Opt. Soc. Am.*, 23: 359, 1933.

SOCIETIES AND MEETINGS

THE VIRGINIA ACADEMY OF SCIENCE

THE Virginia Academy of Science held its fifteenth annual meeting at the University of Virginia, on May 6, 7 and 8, with a registration of 376. The public address on Friday night was given by Professor Ernest Orlando Lawrence, of the University of California, under the joint auspices of the academy and the University of Virginia Chapter of the Society of Sigma Xi. The subject of his address was "Atoms, New and Old."

The Academy Prize of $50.00 was awarded to Professor R. G. Henderson, of the Virginia Polytechnic Institute, for a paper entitled "Studies on the Downy Mildew Disease of Tobacco," and the Jefferson Gold Medal was awarded to Dr. William Branch Porter, of the Medical College of Virginia, for a paper entitled "Heart Changes and Physiologic Adjustment in Hookworm Anemia." Honorable mention was also accorded to J. R. Dietrich for a paper entitled "Propagation of Potential in Discharge Tubes" and to R. W. Quarles and A. F. Benton for a paper entitled "Heats of Absorption of Gases on Sodium Fluoride." One hundred and seventy-nine papers were presented in the sectional meetings, 39 being in the Section of Astronomy, Mathematics and Physics, 50 in Biology, 29 in Chemistry, 11 in Education, 25 in Geology, 17 in Medical Sciences and 8 in Psychology. There were also very interesting demonstrations in some of the sections.

The following officers were elected for the coming year:

President: Professor D. Maurice Allan, of Hampden-Sydney College.

Secretary-Treasurer: Dr. E. C. L. Miller, of the Medical College of Virginia.

President-elect: Dr. F. L. Robeson, of the Virginia Polytechnic Institute.

Member of the Council: Dr. Robert F. Smart, of the University of Richmond.

The following are the officers of sections for the coming year:

Astronomy, Mathematics and Physics:

Dr. Preston Edwards, of Sweet Briar College, *chairman.*

Dr. Charles H. Wheeler, III, of the University of Richmond, *Secretary.*

Biology:

Professor L. L. Hill, of Washington and Lee University, *chairman.*

Dr. Paul M. Patterson, of Hollins College, *sub-chairman for botany.*

Dr. W. L. Threlkeld, of the Virginia Polytechnic Institute, *secretary.*

Chemistry:

Dr. M. J. Murray, of Lynchburg College, *chairman.*

Professor Wm. E. Trout, Jr., of Mary Baldwin College, *secretary.*

Education:

Dr. A. M. Jarman, of the University of Virginia, *chairman.*

Dr. C. E. Myers, of the State Board of Education, *secretary.*

Geology:

Dr. A. A. Pegau, of the University of Virginia, *chairman.*

Wm. M. McGill, of the Virginia Geological Survey, *secretary.*

Medicine:

Dr. H. B. Haag, of the Medical College of Virginia, *chairman.*

Dr. I. D. Wilson, of the Virginia Polytechnic Institute, *secretary.*

Psychology:

Dr. Helen Peak, of Randolph-Macon Woman's College, *chairman.*

Dr. R. H. Henneman, of the College of William and Mary, *secretary.*

Following the meeting there were two field trips, one by the geologists, on Saturday afternoon, and one by the Claytonia Club (botanists) extending over Saturday afternoon and Sunday.

E. C. L. MILLER,
Secretary-Treasurer

THE ALABAMA ACADEMY OF SCIENCE

THE fourteenth annual meeting of the Alabama Academy of Science met on the campus of the University of Alabama, Tuscaloosa, on April 2 and 3, with Dr. Walter B. Jones, state geologist and president of the academy, presiding. This was one of the most successful meetings in the history of the academy, for which 140 members and 60 visitors registered. The meetings were held in the Chemistry and in the new Bureau of Mines Buildings. The Junior Academy, which held its fifth annual meeting at the same time in Smith Hall, was attended by 151 members and visitors, with Dr. James L. Kassner, University, and Mr. Matt J. Lawler, Murphy High School, Mobile, acting as counselors.

Registration began at 8:00 A. M. on Friday. A meeting of the executive committee was held at 10:30; a preliminary business meeting at 11:15, with the final business meeting at 5:15 P. M. The reports of the various committees were given and routine business conducted. A resolution in memoriam for Reverend Bede Knapke, of St. Bernard College, Cullman, who died in January, was read by P. H. Yancey, academy councilor to the American Association for the Advancement of Science.

The following officers were elected for 1937–1938.

President (elect of last year): Roger W. Allen, Alabama Polytechnic Institute, Auburn.
President-elect: P. H. Yancey, Spring Hill College, Mobile.
Secretary: Septima Smith, University (reelected for three years).
Councilor to the American Association for the Advancement of Science: Paul Bales, Howard College, replacing P. H. Yancey, Spring Hill College.

Officers held over from last year are:

Treasurer: B. F. Clark, Birmingham-Southern College (one year).
Editor of the Journal: E. V. Jones, Birmingham-Southern College (two years).

The chairmen of sections, vice-presidents of the academy, elected for next year are as follows:

Section I, Biology and Medical Sciences, J. Gordon Carlson, University, replacing C. M. Farmer, State Teachers College, Troy.

Section II, Chemistry, Physics and Mathematics, George W. Hargreaves, Alabama Polytechnic Institute, Auburn, replacing H. D. Jones, Vanderbilt.

Section III, Geology, Anthropology and Archeology, Peter A. Brannon, Montgomery, replacing J. R. Cudworth, University.

Section IV, Industry, Economics and Geography, John Xan, Howard College, Birmingham, replacing Fred B. Riggan, Stockham Pipe and Fittings Company, Birmingham.

The new officers of the Junior Academy are:

President: Clarence Dudley, Phillips High School.
Vice-president: William Pittman, Shades Cahaba High School.
Secretary: Bebe Faust, Woodlawn High School.
Treasurer: Dawson Kendrick, Woodlawn High School—all in Birmingham.

The Academy Award from the American Association for the Advancement of Science was granted to Dr. Septima Smith, of the Zoology Department, University, for aid in her studies of Alabama dragonflies. Dr. Edgar Allen was elected to honorary membership in the academy. He is the second man in the history of the academy to be so selected. Twenty-five new members joined the academy during the year.

The papers were presented in four sections on Friday afternoon and Saturday morning, with additional demonstrations in Nott Hall, School of Medicine. A Dutch luncheon was served on Friday at noon in the basement of Smith Hall. A tea for members and visitors was held in the Main Exhibition Hall, Smith Hall, on Friday afternoon. On Friday evening the annual banquet was held in the beautiful new dining room at Tutwiler Hall, with Dr. Jack P. Montgomery, of the school of chemistry, serving as toastmaster. This was attended by members of both the Junior and the Senior Academy. The feature of the evening was the presidential address, given by Dr. Walter B. Jones, on the subject, "Conservation of our Natural Resources." This was followed by the first showing, except a preview in Washington, of a two-reel movie entitled "Temples and Peace," a sound picture of the Moundville culture, courtesy of the National Park Service. The invocation was given by the Reverend P. H. Yancey, of Mobile. Dr. George Hutcheson Denny, chancellor of the university, gave the address of welcome, with the response by Peter A. Brannon, curator, Department of Archives and History, Montgomery.

Section III held a geological and archeological field trip on Saturday morning, visiting Mound Park, site of the celebrated Moundville culture, Moundville, Alabama; and the famous Havana gullies, carved in the variegated clays of the Tuscaloosa formation of Cretaceous Age. The trip was conducted by Dr. Walter B. Jones.

The official meeting closed on Saturday at noon with a complimentary barbecue, given by the university in Smith Hall Park.

Many visitors remained for the public lecture on Saturday night by Dr. Edgar Allen, of Yale University, on the subject, "Internal Secretions and Reproduction," held under the auspices of the local Sigma Xi club, by courtesy of the University of Alabama, sponsored by the national organization of Sigma Xi Fraternity. This was accompanied by lantern slides and motion pictures. Field trips to the plant of the Gulf States Paper Corporation, Bryce Hospital, Veterans Facility, University of Alabama, the ravines and bluffs along the Warrior River, and Mound Park filled Saturday afternoon preceding the lecture.

SEPTIMA SMITH,
Secretary

SPECIAL ARTICLES

THE OCCURRENCE IN MAMMALIAN TISSUE OF A LIPID FRACTION ACTING AS INHIBITOR OF BLOOD CLOTTING[1]

WE have found that cerebroside fractions obtained from brain of sheep and pigs contain a substance which acts as inhibitor of the clotting of blood and plasma. While the activity of the inhibitor fractions obtained from different batches of tissue varied considerably, in every case an active fraction could be

[1] This work has been made possible by a grant from the Carnegie Corporation of New York in aid of the study of the mechanism of thrombosis and embolism.

isolated which had the same solubility properties. A substance of similar activity also has been isolated from a crude lipid extract of spinal cord of cattle, which was kindly placed at our disposal by Dr. D. Klein, The Wilson Laboratories, Chicago, Illinois.

The organs were dehydrated with acetone and freed of sterols, fats, lecithin and cephalin by exhaustive extraction with acetone and ether. It is essential to remove the ether-soluble phosphatides as completely as possible, since otherwise the inhibitor may be overshadowed by the cephalin which, as is well known, activates blood clotting. The organ powder is then repeatedly extracted at boiling temperature with ethyl alcohol or a mixture of three parts of methyl alcohol and one part of chloroform. The crude material is dissolved in a mixture of two parts of chloroform and one part of ethyl alcohol. A first crop of cerebrosides is obtained on cooling of the solution and further batches are collected by stepwise concentration of the mother liquors.

When tested according to the technique recently described,[2] the first two or three cerebroside crops thus isolated usually show an inhibiting effect on the clotting of chicken plasma, and all but the weakest preparations also markedly inhibit the clotting of blood and of chicken plasma activated by addition of muscle extract. On the basis of its solubility properties a concentration of the active fraction is possible. It is insoluble in acetone, little soluble in cold pyridine and ether, easily soluble in cold glacial acetic acid and chloroform, and can be recrystallized from methyl alcohol or ethyl acetate. These properties indicate that the inhibitor accompanies the sphingomyelin fraction, whereas cerebron and kerasin are devoid of activity. That sphingomyelin itself does not exert the inhibiting effect can, however, be shown by the fact that sphingomyelin preparations purified by precipitation with Reinecke salt[3] are inactive. Our purest preparations contain N and P, but only small amounts of S. It appears highly improbable that heparin, which has entirely different solubility properties, is the active constituent of this lipid inhibitor. In Tables I and II examples of the action of preparations from sheep brain and beef spinal cord are given. The inhibitor from sheep brain is one of the strongest obtained so far.

It may be relevant to point out that the question as to whether heparin is the physiological agent which controls the fluidity of blood is by no means settled.

TABLE I
LIPID INHIBITOR FROM SHEEP BRAIN

Mg in 0.1 cc of plasma or blood	Clotting time minutes		
	Activated chicken plasma	Recalcified oxalated human plasma	Human blood
0	9	2	4
0.031	36	..	...
0.062	54	8	...
0.124	90	18	100
0.249	> 250	51	150
0.498	> 250	82	...

TABLE II
LIPID INHIBITOR FROM BEEF SPINAL CORD

Mg in 0.1 cc of plasma	Clotting time minutes	
	Chicken plasma	Activated chicken plasma
0	97	7
0.10	135	9
0.20	225	14
0.39	255	18
0.78	345	25

In order to isolate heparin from tissue comparatively drastic means are necessary. We have found in experiments which have not yet been published that, when a mild method of extraction is employed, it is impossible to liberate heparin even from liver, in which it is known to occur in considerable amount. It may be that the lipid inhibitor described above will prove of interest in connection with the problem of clotting inhibitors contained in blood and in thrombocytes.[4]

The work here described is being continued and will be published in detail at a later date.

ERWIN CHARGAFF
COLLEGE OF PHYSICIANS AND SURGEONS
COLUMBIA UNIVERSITY

[2] E. Chargaff, F. W. Bancroft and M. Stanley-Brown, *Jour. Biol. Chem.*, 115: 149, 1936.

[3] S. J. Thannhauser and P. Setz, *Jour. Biol. Chem.*, 116: 527, 1936.

[4] E. Chargaff, F. W. Bancroft and M. Stanley-Brown, *Jour. Biol. Chem.*, 116: 237, 1936.

THE DECOMPOSITION OF YEAST NUCLEIC ACID BY A HEAT RESISTANT ENZYME

IN the course of a study of the action of different extracts of animal tissues upon pneumococci, preparations have been obtained which exhibit a high degree of enzymatic activity upon yeast nucleic acid.[1] The enzyme has been prepared from polymorphonuclear leucocytes and from several organs, especially the liver, pancreas, spleen and lungs of different animal species. It possesses certain interesting properties, which are the same irrespective of the source from which it is prepared.

The enzyme, a polynucleotidase, is remarkably resistant to heat, with a zone of maximum stability

[1] The author is indebted to Dr. P. A. Levene for supplying him with a sample of yeast nucleic acid.

around pH 4 to pH 5; even at pH 1.5 and pH 7.5 the enzyme can be heated in a boiling water bath for five minutes with only little loss of activity. The rate of action upon yeast nucleic acid increases with temperature up to 75° C.; it then decreases sharply and no appreciable action can be detected at 85° C. When an enzyme-substrate mixture is maintained at 95° C. no enzymatic hydrolysis occurs; if, however, the same mixture is now brought back to a temperature compatible with enzymatic activity (60° C., for instance), the nucleic acid is rapidly decomposed, indicating that the inhibiting effect of high temperatures upon the enzyme-substrate mixtures is completely reversible.

The enzyme appears to be a protein; it is readily salted out in saturated sodium sulfate solutions; it is rapidly decomposed by pepsin, but is very resistant to trypsin and chymotrypsin.

After being acted upon by the polynucleotidase, the yeast nucleic acid becomes soluble in mineral acids and glacial acetic acid; the purified preparations of the enzyme, however, do not release any inorganic phosphorus from yeast nucleic acid or indeed from any phosphoric esters tested. *In other words*, the enzyme does not behave as a phosphatase. No action could be detected upon thymus nucleic acid.

In 1913 Jones[2] stated that he had observed in a preparation of digested pancreas the existence of a principle capable of breaking down yeast nucleic acid into dinucleotides. This observation does not seem to have been confirmed and the same author himself stated later that "it has been found difficult to repeat this experiment."[3] It appears, however, that the enzyme described in the present paper may be the same as that discovered by Jones.

As stated elsewhere, the same enzyme preparations which decompose yeast nucleic acid are also capable of rendering heat-killed pneumococci Gram negative.[4] It appears possible that the same agent is responsible for both types of actions, since the effect of temperature, of trypsin and of pepsin is common to both reactions. Furthermore, it has been possible to extract from pneumococcus cells a soluble fraction which reacts like nucleic acid and which is readily decomposed by the enzyme.

Finally, it may be stated that several samples of crystalline trypsin and chymotrypsin[5] have been found to contain small amounts of a heat-resistant principle which attacks both yeast nucleic acid and heat-killed pneumococci. Both types of action could be completely eliminated by repeated recrystallizations of the proteolytic enzymes.

RENÉ J. DUBOS

HOSPITAL OF THE ROCKEFELLER
INSTITUTE FOR MEDICAL
RESEARCH, NEW YORK

[3] W. Jones, *Monographs on Biochemistry*, 37, 1914.

[4] R. Dubos and C. M. MacLeod, *Proc. Soc. Exp. Biol. and Med.* In press.

[5] The author is indebted to Drs. J. H. Northrop and M. Kunitz for supplying him with several samples of crystalline trypsin and chymotrypsin.

THE PREPARATION OF CRYSTALLINE β-4-GLUCOSIDOSORBITOL AND ITS NONOMETHYL DERIVATIVE

RECENTLY Karrer and Büchi[1] reported on the reduction of cellobiose to β-4-glucosidosorbitol. They failed to obtain the substance in crystalline form or analytically pure. In view of the importance which this method of catalytic reduction is acquiring in the domain of sugar chemistry, we wish to report on the preparation of β-4-glucosidosorbitol in form of beautifully crystalline platelets, melting at 133° C. and having a specific rotation in water, $[\alpha]^{25}_{D} = -8.7°$.

The reduction of the cellobiose was carried out in aqueous solution under pressure of 100 atmospheres in the presence of Raney's catalyst, the temperature being 75° during 8 hours of each day, the remaining part of each day the temperature remaining at about 25°. The operation lasted 48 hours.

The composition of the substance was C 41.83, H 7.21. Calc. C 41.83, H 7.03.

A single methylation with dimethylsulfate under conditions of West and Holden gave an exhaustively methylated product, which distilled at 170° and 0.2 mm pressure. The specific rotation of the substance was $[\alpha]^{25}_{D} = -4.93°$ (absolute ethanol) and the composition of the substance was C 53.34, H 9.01, OCH_3 58.91. The theory required C 53.37, H 9.00, OCH_3 59.32.

P. A. LEVENE
MARTIN KUNA

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK, N. Y.

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THE DEVELOPMENT OF THE NATURAL SCIENCES IN CHINA[1]

By Dr. AMADEUS WILLIAM GRABAU

THE GEOLOGICAL SURVEY OF CHINA

I AM deeply conscious of the honor which you, the foremost body of scientific men of my country, have conferred upon me.

That I have been able to take an active part in the development of the natural sciences in China has been due, in the first place, to the fact that my coming to Peking has coincided with the awakening of interest in, and desire for scientific education along western lines, among the Chinese intellectuals.

The Geological Survey of China had been founded a few years before, and it had but recently completed its first task—the training of a number of men in the fundamentals of geological science.

It was still housed in an old adapted and inadequately equipped compound, with a library consisting of a few hundred books, and a few drawers of Chinese Paleozoic fossils. But, new buildings were under construction, and under the energetic guidance of Drs. Chang, Ting and Wong, phenomenal progress was made in the equipment and acquisition of material and the investigation of Chinese geology. Dr. J. G. Andersson, foreign adviser to the Survey, had organized the scientific exploitation of the important deposits of fossil vertebrate remains and the study of these was undertaken by foreign paleontologists.

To me was assigned the study of the Chinese invertebrate fossils, while my task at the university has been the training of young Chinese paleontologists and stratigraphers.

Through the efforts of Dr. Andersson a fund had been provided to begin the publication of the Paleon-

[1] Remarks on receiving the Mary Clark Thompson Medal of the National Academy of Sciences. Read by Mrs. Grabau in the absence of Dr. Grabau in China.

ologia Sinica in four series: A. Fossil Plants; B. Fossil Invertebrates; C. Fossil Vertebrates, and D. Ancient Man. The support of this was subsequently taken over by the Survey.

The first two fascicles which I prepared appeared one in April and the other in September, 1922. Since then 95 fascicles have been issued with a total of 8,760 quarto pages and 844 plates. If we add the fascicles in press, or prepared, the total number of fascicles is well over a hundred, with more than 9,000 pages. The smallest fascicle comprises 14 pages and 1 plate, and the largest 441 pages and 31 plates.

The first paleontological memoir, written by a Chinese paleontologist, Dr. Y. C. Sun, appeared in 1924, and of the 43 fascicles of Series B, so far issued, 32 have been written by Chinese. Nearly all these are graduates of the National University.

At first graduate students had to be sent abroad for the study of vertebrates, but in recent years the preliminary training of workers in that field is carried on in Peking. This was made possible by the founding of the Cenozoic Laboratory of the Survey, which now takes care of all the work on fossil vertebrates, including the researches on the Peking Man (*Sinanthropus pekinensis*) under the direction of Drs. Weidenreich and Young and Pere Teilhard de-Chardin. Additional impetus had previously been given by the explorations of the Third Asiatic Expedition under Dr. Andrews and the coming to Peking of such internationally famous men as Granger, Matthew Nelson, Chaney, Berkey and the Swedish scientists under Sven Hedin, and his royal highness the Crown Prince of Sweden, an active patron of science.

The Survey has since acquired the Chaukoutien site and provided the necessary equipment for the extensive exploitation of these now famous deposits of the remains of ancient man.

The Soil Survey and Seismological Observatory in the Western Hills are other lines along which the Survey has branched out, in addition to its active pursuit of the study of the structural geology and economic deposits of China and the making of geological maps.

In 1920 the geological department of the university was reorganized and under the guidance of such leaders as Drs. J. S. Lee, C. Y. Hsieh and the late V. K. Ting and others it developed rapidly. It is now housed in a building of its own, well equipped with lecture halls, laboratories, museum and library. The geological faculty consists of seven professors, two lecturers and four assistants.

Of the several hundred graduates of the department, the great majority is still in active geological work. Many of them are members of the national or of the various provincial surveys; others are teaching in various universities. The department now has resumed issuing its series of contributions, of which twelve have appeared, while others are in press.

In 1922, the Geological Society of China was organized with twenty-six charter members. At the first meeting (March 2) thirty-six new fellows and nine associates or student members were elected. Fifteen papers were presented, and the first volume of ninety-nine pages was published that year. Volume XV, totalling 574 pages, appeared in four parts during 1936.

At the annual meeting in February, 1937, sixty papers were presented and the membership was as follows:

Number of fellows	320
Number of student associates	66
Number of foreign corresponding members	36
Number of living honorary members	1
Number of institutions, listed as members	6
Total	429

When I came to China, a Chinese fellow passenger, Dr. C. C. Ping, was returning after several years of study at Cornell University. It was an opportunity for discussing plans to develop research in natural history in China, for Dr. Ping was to take charge of the biological laboratory of the Science Society of China. This society was organized a few years previously for the promotion and diffusion of science. It publishes a monthly journal *Science* in Chinese, which is now in its twenty-first year. Active work in the investigation of the fauna and flora of Central China was begun at once under Dr. Ping, the results appearing in English in numerous bulletins issued at irregular intervals. In Peking we organized the Peking Laboratory of Natural History, under the sponsorship of Mr. Sohtsu King, who has since become one of China's patrons of science. During two seasons he maintained a seaside laboratory at Peitaiho, where we collected the material for our illustrated guide to the shells of Peitaiho, in which 120 species were described and figured. Mr. King, who has since been elected to membership in several foreign malacological and conchological societies, has brought together the most complete library on conchology in China, and he and Dr. Ping are periodically issuing fascicles on the South Coast shells.

When the Fan Memorial Laboratory of Biology was organized, it took over most of the plans of the original Peking Laboratory, including the publication of the Zoologia Sinica, and extensively developed them, and since moving into its new and well-equipped quarters, it has become one of the leading biological research institutions of China.

Another direct outcome of the early activities of the Peking Laboratory of Natural History was the organi-

zation of the Peking Society of Natural History in 1925. The call was issued by Dr. N. Gist Gee, the ornithologist, as organizing secretary, and myself as convener, and the first meeting was held on September 21, with thirty-eight charter members.

Monthly meetings have been held ever since, with lectures and discussions on Chinese natural history. During the first year the membership rose to 101, including eighteen foreign correspondents and two honorary members. The society began at once to issue a bulletin, the first volume of 450 pages appearing in 1926. The present membership is 160 active members, 26 foreign correspondents and 4 honorary members, and the bulletin is now in its eleventh volume.

Besides this the society has undertaken the issue of the handbooks, of which four have appeared: (1) "Flowers of Peitaiho," by R. D. Wickes; (2) "Shells of Peitaiho," by Grabau and King, second edition; (3) "Hand-book of North China Amphibia and Reptiles," by Drs. Boring, Liu and Chou, and (4) "Familiar Trees of Hopei," by H. F. Chow.

In addition the society has issued five monographs on Chinese medicinal plants and animal drugs, by Dr. Bernard Read, and one on minerals and stones used in medicine, by Drs. Read and Pak. It has also brought out a profusely illustrated manual of the dragon-flies of China, by Dr. J. G. Needham.

The scientific study of natural history is now a recognized intellectual pursuit in China, and those of us who were privileged to be present and in a measure give aid, during the early years of development, feel confident that in the years to come geological, paleontological, biological and archeological contributions by Chinese naturalists will become of increasing importance, not only to their home country, but to the world of science at large.

Chinese naturalists feel as I do, that in honoring me to-night you are giving recognition to the progress of the scientific work in China, and they take it as an encouragement for the unabated continuance of their endeavors.

With this interpretation of your award to me of the Thompson Medal and with my sincere personal thanks, I accept the honor.

THE SOCIAL RESPONSIBILITY OF THE ENGINEER.[1]

II

By Dr. F. G. COTTRELL

RESEARCH ASSOCIATES, INC., WASHINGTON, D. C.

The particular project out of which have thus far evolved the Research Corporation and the Research Associates, Inc., originated over 30 years ago at the University of California primarily in the attempt to make certain technical developments arising in the laboratories more certainly and usefully available as practical results to the public on the one side and on the other securing therefrom some financial return toward further research in these laboratories.

The idea was not a new one even at that time, but concrete systematic attempts at its realization were few and scarcely any had as yet attracted much public attention.

The particular technical developments and patents giving us a basis to work on at the time happened to concern the application of electricity for the suppression of dust and smoke discharge from smelters and chemical works, some of which were then in serious litigation with surrounding agricultural regions. The scientific and technical side of this story though interesting in itself is not what I wish to cover to-night, as it is already fully available in the now voluminous published literature on the subject.[2]

Suffice it to say that these electrical methods, though originally proposed and even patented in their broadest general terms a quarter of a century earlier, had never up to then been successfully engineered and applied in industry. The work started purely as a private venture, a summer vacation's excursion into the technical commercial field when it was drastically necessary to supplement a university instructor's salary by outside work of some sort. It soon involved three associates besides myself, all alumni of the university, *viz.*, Dr. Harry East Miller, a consulting chemist (the only other member of our group still living), Professor Edmond O'Neill, of the Chemical Department, and Mr. E. S. Heller, a lawyer of San Francisco. They jointly financed the undertaking, including patents and early experimental work. As we proceeded, the scope and importance of the field we had stumbled upon gradually became evident.

None of us looked to this particular work as anything but a passing, though interesting and useful, incident of our chosen careers. Early in its development we therefore planned for its eventual liquidation as far as we as a group were concerned, but agreed that in so doing we would if possible segregate a part of the patent rights and turn them over to the univer-

[1] Address on the occasion of the presentation of the Washington award at a meeting of the Western Society of Engineers, Chicago, February 23, 1937.

[2] For brief summary and selected bibliography see "Fume Precipitation, Electrical," Encyclopaedia Britannica, 14th Edition, Vol. 9, p. 914, *et seq.*

sity or some other appropriate body as nucleus and example of this particular sort of endowment for further scientific research.

It took five years and an investment of over $20,000, tenfold the original estimate of both time and money, before we reached even a promising point to pause and attempt such liquidation and transfer of patent rights. In the meantime (1907) we found it expedient to incorporate two companies, the Western Precipitation Company, handling actual installation of the process at home, and International Precipitation Company, holding the foreign patents for which our perhaps amateurish enthusiasm had led us to apply in some sixteen countries.

Our five years' experience made us skeptical of the expediency of universities themselves attempting to administer the commercial development or licensing of patents, partly from the difficulty and financial hazards of the business but even more from the danger of its reaction on the aims and outlook of the institutions, including the possibility of gradual development of commercial competition among them and resulting interference with free exchange of scientific ideas.

This led to our turning to the national scientific societies as possible trustees in such matters for all the universities and other academic research institutes as a group, but none of these national societies felt they could undertake it. The quest finally led us to the Smithsonian Institution, which, though hesitating to undertake the task itself, sponsored an attempt to get together a volunteer group of nationally recognized men, representing both business and science, to form a business corporation to take over these and any other patent rights that might be offered from time to time from any source as endowment for science. It took two months to get a board of 15 together and perfect plans. As the result Research Corporation was chartered on February 26, 1912, just 25 years ago next Friday, under the laws of New York State with an authorized capital of $20,000, of which $10,100 was paid in practically as a loan without interest by the directors themselves and a few others interested in the experiment.

I well remember one of these latter remarking at the time: "Your project of a non-profit but business corporation strikes me as too bizarre and self-contradictory to succeed, but if these busy and successful business men you have secured as directors are willing to give their time and effort to the experiment, they can count on me for a thousand dollars toward trying it out." Nor do I recall that he was any more frankly surprised three years later when he got his money back out of earnings than some of the directors themselves. At the start it was frankly "An Experiment in the Public Administration of Patent Rights." At least that is what I called it in the title of a paper written at the time, though I am not sure that even a majority of its original board of directors took that aspect of the project as seriously as I did. They saw it primarily as just so much more endowment for science and possibly if successful, as facilitating and encouraging future additions in kind, but even of this latter some were frankly skeptical.

Nor was there lack of justification for this skepticism. It has taken good hard work over the years by an intelligent and devoted staff sympathetically supported and guided by an interested and unselfish board to accomplish the success manifest to date.

At the time of organizing Research Corporation the investment of the original California group had not yet even begun to be repaid, but the business outlook for the Western Precipitation Company seemed encouraging. I was leaving the university faculty for service with the U. S. Bureau of Mines especially on smelter fume problems closely connected with litigation thereon, so it was necessary to completely separate myself from any financial interest bearing on the subject. This precipitated similar action on the part of my three associates. Some of our clientele among the smelters and chemical works where a number of electrical precipitation plants were under construction were somewhat perturbed at the prospect of becoming guinea pigs in the Research Corporation experiment through absorption of Western Precipitation Company therein and so expressed themselves. Some of the younger men in our technical staff were quite anxious to carry on by themselves, and this permitted a very happy solution by which one of them, Mr. Walter A. Schmidt, another University of California alumnus and former student there of mine, headed a group to take over, refinance and practically consolidate the Western and International Precipitation Companies under the former, after we had segregated and turned over to the Research Corporation entirely unencumbered all the United States patent rights to the precipitation business east of the Rocky Mountains except the one application to the Portland Cement industry which Mr. Schmidt had already personally built up over several years under an earlier license from us.

This also incidentally provided a very interesting yardstick alongside of the Research Corporation experiment, for Western Precipitation Company continued on as a normal privately owned enterprise operating under the same patents and among the same industries in a different geographic field in part of its work and with a different industry but in the same geographic field as Research Corporation in another. An agreement was early reached between the two corporations for the free exchange of all new information and patents on electrical precipitation and has later

grown to include similar organizations in many foreign countries.

But to return to the Research Corporation itself: We had pictured its functions as primarily hunting up business, negotiating licenses and collecting royalties. However, experience soon showed that even in as new an art as electrical precipitation, where we were the recognized pioneers of its effective industrial application, it was necessary for the corporation to furnish its clientele not only licenses but active and vigorous service in detailed design and leadership in adapting the new art to the special conditions of each industry and even each individual plant. Otherwise failures due to such details were viewed as fundamental limitations of the process as such and seriously cramped further growth and expansion. On the other hand, too, if the client solved the new difficulties unaided he quite naturally and properly was apt to take out patents of his own covering it. Now there is nothing more discouraging to the prospective user of a new process than to find that he may have to shop around among several interests to collect the patent rights he needs.

The realization of this early forced the Research Corporation to take an active and responsible part in the design and supervision of installations under its patents, and finally led it as the only satisfactory way to the building up of its own construction department and contracting to put in and guarantee performance of the whole equipment.

I mention this to illustrate how inexorably responsibilities grow in the economic field even in an organization which started out with apparently so simple a program.

Another important difference in the actual course of events as compared with the original plans and forecasts lay in the slower development of income both from electrical precipitation and from other business than many had expected.

From the very start the corporation was, to be sure, deluged with offers of patents and patentable ideas on all sorts of terms by all sorts of inventors. Hundreds of these cases were carefully investigated at considerable expense. Definite attempts to commercialize a few were made, and much assistance was incidentally given to a large number of applicants in the way of technical and legal advice and in making favorable contacts with firms and industries who might be interested in the further development of projects in cases where the Research Corporation did not feel itself in a position to proceed further.

Only relatively recently, however, has the corporation begun to receive significant financial returns outside the electrical precipitation field, but these seem now to be steadily growing, both in number and importance, and they include as widely different subjects as air conditioning, both for buildings and railway service, sewage disposal and pharmaceutical products.

Perhaps the most significant lesson out of all this, particularly for the purpose of our discussion this evening, is, on the one hand, the demonstration that it is entirely possible to organize and efficiently operate over long periods of years, on a thoroughly sound business basis, a corporation of the type here described in which there are no dividends to individual stockholders, no bonds or other long-term borrowings entailing heavy interest payments which in slack business seasons embarrassingly compete with wages and salaries, while, on the other hand, it equally illustrates the difficulty and general inexpediency of trying to handle intensively more than one new thing at a time, especially when getting under way with a new organization. But this is just the reason why this very method of organization presents, I believe, a particularly suggestive challenge to the engineer with new ideas who may be finding it difficult to get them tried out under conditions acceptable to him, through older established channels in industry and trade.

While the Research Corporation finds itself almost chronically in a condition near saturation and ofttimes actually supersaturated in regard to new commitments in the development field, and therefore must select very carefully and conservatively among them, it has come to be a very large part of its public service functions to aid and advise others who seriously contemplate entering this field.

There has also come to be a constant exchange of information and assistance going on between it and other similar organizations, such as the university research foundations, National Research Council, the various technical departments of the Government, the Chemical Foundation, the Ontario Research Foundation, and many others. So much so in fact that among this group it is being considered whether some sort of intergroup organization, to arrange for regular meetings of representatives for the discussion of common problems and aims, has not already become highly expedient. This might quite conceivably be the next step in the development of this part of our social-economic pattern.

At the outset Research Corporation's income was small and slow growing. Its capital was gradually eaten into, reaching a minimum of about $3,000 in the third year of operations, shortly after which the first considerable license contracts were entered into with some of the large smelting companies and the corporation's reserves rapidly increased, reaching a maximum of slightly over $200,000. But conditions of the world war and the post-war depression again ate steadily

into these reserves until in 1926–7 they were once more just about dragging on bottom, when a slow but steady climb again set in with naturally a decided spurt in the boom year of 1929 and lasting well into 1930, again building up a substantial reserve sufficient to more than completely meet actual deficits suffered in 1931 to 1933, as well as to permit the corporation to continue its grants for pure scientific research at the Smithsonian Institution and a number of universities and other research centers, totalling $50,000 to $75,000 a year. The past two years have again been "in the black" and 1937 opens with encouraging prospects.

Nearly a decade ago, when the Research Corporation began to feel itself gradually emerging from the effects of the post-war depression and keenly realizing the difficulties of too closely mixing operation and construction technique with research in a new field, it decided to set up a modest branch laboratory, primarily for this latter purpose, in Washington, D. C., which would also supply a much needed link with a large store of technical information available there through the libraries and information services of the various scientific departments.

Through the friendly cooperation of the Smithsonian Institution modest temporary quarters for this step were soon found and work started, particularly along lines growing out of activities to which the Research Corporation was already committed. One of the more important projects resulting from this move and which will serve to illustrate the work in a general way, was the cooperative investigation undertaken with the Tennessee Valley Authority (then just established) and the Department of Agriculture, having to do with semi-commercial tests and development in the application of blast furnace technique to the production of phosphate fertilizers.

By the end of 1934 the work at Washington had developed to a point where the directors of the Research Corporation felt it expedient, in conformity with the general policy of decentralization indicated above, that this Washington work should be given a more independent status and thus, among other objects, stimulated to become more definitely and rapidly self-supporting and eventually take its place alongside of the Research Corporation, functioning in much the same way but on separate technical projects and with an entirely separate board of its own.

It was felt that this budding-off process might become one of the most effective ways of providing for wider public service in this promising field and also to a drafting in and giving full scope to new personal initiative.

Accordingly, the Research Associates, Inc., was chartered on January 3, 1935, and has been operating ever since with a staff of ten or a dozen people housed in several temporary small laboratory buildings, mostly relics of the chemical warfare unit of war days, on about an acre of ground, part of the campus of the American University and immediately adjacent to the old Fixed Nitrogen Research Laboratory of the U. S. Department of Agriculture.

Thus far the new corporation has been supported almost entirely by grants from the Research Corporation, but it is hoped that by the end of the present year it will have become self-supporting from its own developments. The first to emerge will probably be in the field of non-glare automotive lights on the one hand, and certain improvements in the soap and detergent industry on the other; with a more ambitious long range program already well under way on fundamental improvements in heat exchange, especially in high temperature chemical and metallurgical industries and power production. But the new corporation, though an interesting and lusty youngster, is still distinctly not out of its swaddling clothes, and, as even in this modern age the old adage that "children should be seen but not heard" is still reasonably applicable, Junior, I trust, may, with this brief introduction, be allowed to retire again to the nursery until there are more definite accomplishments to report.

SCIENTIFIC EVENTS

THE BIOLOGICAL LABORATORY AT COLD SPRING HARBOR

THE summer activities of the Biological Laboratory of the Long Island Biological Association at Cold Spring Harbor will open on June 21 with the first meetings of the course in surgical methods in experimental biology and the course of experimental endocrinology. The class in surgical methods, which is now over-registered, is again being given by Dr. George W. Corner, of the University of Rochester, while that in experimental endocrinology is being given by Dr. H. O. Haterius, of the Ohio State University, and Dr. Robert Gaunt, of New York University. The Davenport Laboratory, in which these classes are being held, has been completely remodeled, and accommodations for an animal colony have been added.

The fifth of the Cold Spring Harbor symposia on quantitative biology begins on June 22 and continues for five weeks. This year the subject is that of internal secretions, with special emphasis on their chemical aspects and on bio-assay. The program falls into three main sections—I. Pituitary and gonad hormone chemistry (first week); II. Pituitary-gonad relations (second and third weeks), and III. Hormones and

metabolism (fourth and fifth weeks)—and is made up of 45 papers read by 43 contributors. The participants will be in residence at the laboratory for all or an appreciable part of the five weeks' period. Investigators who are interested may attend and take part in the discussion of the papers, and programs will be sent on request. The papers, together with edited discussion, will be published as Volume V of the Cold Spring Harbor Symposia on Quantitative Biology and will be ready for distribution early in November.

Commencing on August 2, the laboratory is offering courses in marine and fresh-water zoology, given by Dr. Herman T. Spieth, of the College of the City of New York, and Dr. William A. Castle, of Brown University, and in plant sociology, given by Dr. Stanley A. Cain, of the University of Tennessee. These combine laboratory work with field work, making use of the great variety of habitats which are found within easy working range of Cold Spring Harbor.

The research work which will be in progress during the summer is in part a continuation of the all-year-round work in biophysics and physiology, and in part the work planned by visiting investigators. The problems of special interest this summer include: the study of surface conductance and the interpretation of impedance measurements on cell membranes; the effect of x-rays on various complex organic molecules; electrophoretic investigations of protein surfaces and of the surfaces of red and white cells under various conditions; the estimation of histamine in blood by iontophoresis; investigations on intravascular hemolysis, particularly in relation to toxic benzol derivatives; the synthesis of simple hemolytic glucosides; the metabolism of different varieties of white cells, and the light transmission cell properties of cell suspensions. Drs. Haterius, Gaunt, Nelson and Donahue will also be working upon a number of problems in endocrinology, and it is hoped this summer to commence projects on the hematology of the fishes.

As in past years, a series of evening lectures on scientific topics of general interest have been arranged, and these lectures are given each Tuesday throughout the season. Dr. Harold A. Abramson will also give a series of five lectures on "Allergy and its Mechanisms" on Fridays from June 25 onwards. These lectures will deal with allergic phenomena from the standpoint of physics and physical chemistry.

Those interested may obtain further information by writing to Dr. Eric Ponder at the Biological Laboratory.

THE NEW ORLEANS MEETING OF THE AMERICAN ASSOCIATION OF MUSEUMS

Museum News reports that the New Orleans meeting of the American Association of Museums, which met on May 3, 4 and 5, drew an attendance of 200 members, of whom more than 150 were out-of-town delegates.

Papers read at this, the first meeting in the South since the Charleston meeting of 1923, brought out the fact that museum conditions in that section have changed materially in the past year and a half. At least ten new museum buildings have been constructed in the South during that period, work has been begun on an eleventh, and plans have been drawn and work done on exhibits for a twelfth. In addition two old buildings have been converted to museum use; a number of new museums have been opened in National Park and Monument headquarters, and many old structures have been made into historic house museums. Every state south of the Mason and Dixon line has shown some new museum activity, and in the number of new museum buildings erected Texas led the nation.

Herbert E. Winlock, director of the Metropolitan Museum of Art, was reelected president of the association. Section chairmen were elected as follows: Art Section, Wilbur D. Peat, director, John Herron Art Institute, Indianapolis; Education Section, Thomas Munro, curator of education, Cleveland Museum of Art; History Section, Henry C. Shetrone, director, Ohio State Museum, Columbus; National and State Parks Section, William H. Carr, director, Bear Mountain Trailside Museums, Palisades Interstate Park; Public Relations Section, Sarah Newmeyer, publicity director, Museum of Modern Art, New York; Science Section, Charles M. B. Cadwalader, president, Academy of Natural Sciences of Philadelphia; Science Technical Section, Charles R. Toothaker, curator, Philadelphia Commercial Museum; Superintendents Section, John W. McCabe, superintendent, Cleveland Museum of Art. Morgan C. Marshall, director, Walters Art Gallery, Baltimore, continues as chairman of the Art Technical Section and H. L. Story, registrar, Museum of Fine Arts, Boston, of the Registrars Section. A new section, the Children's Museum Section, was organized, under the chairmanship of Mrs. Dean Clay Osborne, chairman of the Women's Auxiliary of the Brooklyn Children's Museum.

The association passed a resolution endorsing the efforts of the State of Louisiana and the City of New Orleans to preserve historic buildings and areas and commending the work already done toward this end.

At the invitation of all the museums of the city Philadelphia was chosen as the meeting place for 1938.

HONORARY DEGREES CONFERRED BY CLEMSON COLLEGE

On the occasion of the dedication of Long Agricultural Hall at Clemson College on May 12, the doctorate of science was conferred on the following:

Henry D. Barker, senior pathologist, Bureau of Plant Industry, U. S. Department of Agriculture.

Henry Walter Barre, principal pathologist, Bureau of Plant Industry, U. S. Department of Agriculture.

Hugh Hammond Bennett, chief, Soil Conservation Service, U. S. Department of Agriculture.

Cloide Everett Brehm, director, Agricultural Extension Work, University of Tennessee.

Harry Lowrance Brown, assistant secretary, U. S. Department of Agriculture.

Thomas Stephen Buie, regional conservator, Soil Conservation Service, U. S. Department of Agriculture, Spartanburg, S. C.

Paul Wilber Chapman, dean, College of Agriculture, the University of Georgia.

Cully Alton Cobb, director, Southern Division, Agricultural Adjustment Administration, Washington, D. C.

David Robert Coker, president, Coker's Pedigreed Seed Company, Hartsville, S. C.

Thomas Poe Cooper, dean, College of Agriculture, director, Agricultural Experiment Station and Extension Service, the University of Kentucky.

Chester Charles Davis, member, Board of Governors, Federal Reserve System, Washington, D. C.

Ivy William Duggan, assistant director, Southern Division, Agricultural Adjustment Administration, Washington, D. C.

James Allen Evans, administrative assistant, Extension Division, College of Agriculture, the University of Georgia.

George Elbert Freeman, head, Division of Vocational Education, state supervisor of vocational agriculture, Nashville, Tenn.

Marion Jacob Funchess, dean, School of Agriculture; director, Alabama Experiment Station, Alabama Polytechnic Institute, Auburn.

Wightman Wells Garner, principal physiologist, Bureau of Plant Industry, U. S. Department of Agriculture.

Edward Walter Garris, professor of agricultural education, College of Education and College of Agriculture, the University of Florida.

Wilson Gee, professor of rural social economics, director of the Institute for Research in the Social Sciences, the University of Virginia.

Dan T. Gray, dean, College of Agriculture; director, Agricultural Experiment Station and Extension Service, the University of Arkansas.

Hardrada Harold Hume, assistant dean, research, College of Agriculture; assistant director, research, Agricultural Experiment Station, the University of Florida.

John Redd Hutcheson, director, Extension Work in Agriculture and Home Economics, Virginia Polytechnic Institute.

Thomas Barksdale Hutcheson, agronomist, Agricultural Experiment Station, head, Agronomy Department, Virginia Polytechnic Institute.

James Tertius Jardine, director of research, chief, Office of Experiment Stations, U. S. Department of Agriculture.

George Wannamaker Keitt, professor of plant pathology, the University of Wisconsin.

Asbury Francis Lever, director of public relations, Farm Credit Administration, Columbia, S. C.

Walter Hoge MacIntire, head, Department of Chemistry, the University of Tennessee Agricultural Experiment Station.

James Spencer McHargue, head, Department of Chemistry, Kentucky Agricultural Experiment Station, the University of Kentucky.

William Dewey Moore, pathologist, U. S. Department of Agriculture, Tifton, Ga.

John Harcourt Alexander Morgan, director, Tennessee Valley Authority, Knoxville.

Lake Rosse Neel, editor and writer, *Southern Agriculturist;* vice-director, Middle Tennessee Experiment Station, Columbia.

Wilmon Newell, dean, College of Agriculture; director, Agricultural Experiment Stations and Extension Service, the University of Florida.

Mark Lovel Nichols, principal engineer, Soil Conservation Service, U. S. Department of Agriculture.

Clarence Poe, president and editor, *The Progressive Farmer and Southern Ruralist*, Raleigh, N. C.

Robert Franklin Poole, professor of plant pathology, plant pathologist, chairman, Graduate Work Committee, North Carolina State College of Agriculture and Engineering, Raleigh.

Tandy Roy Reid, regional director, Resettlement Administration, Little Rock, Ark.

Roe Eugene Remington, professor of nutrition, Medical College of the State of South Carolina, Charleston.

Ira Obed Schaub, dean and director of Agricultural Extension, North Carolina State College of Agriculture and Engineering, Raleigh.

Henry Perkins Stuckey, director and horticulturist, Georgia Experiment Station, Experiment.

Robert William Webb, principal cotton technologist, Bureau of Agricultural Economics, U. S. Department of Agriculture.

George James Wilds, director plant breeding, Coker's Pedigreed Seed Company, Hartsville, S. C.

Rhett Youmans Winters, director, Agricultural Experiment Station, North Carolina State College of Agriculture and Engineering, Raleigh.

Howard Henry Zimmerley, director, Virginia Truck Experiment Station, Norfolk, Va.

RECENT DEATHS AND MEMORIALS

Dr. John Wyckoff, dean of New York University Medical College, died on June 2. He was in his fifty-sixth year.

Madison Grant, a founder of the New York Zoological Society and its president since 1925, died on May 30. He was seventy-one years old.

The death is announced in his fiftieth year of Dr. Harold Bunce Myers, professor of medicine and assistant dean of the University of Oregon Medical School at Portland.

Dr. Lucy Smith Clemens, wife of Dr. W. A.

Clemens, director of the Pacific Biological Station, Nanaimo, B. C., died on May 23. She graduated from Mount Holyoke College in 1909 and received the doctorate degree from Cornell University in 1914. From 1912 to 1918 she was a member of the staff in zoology at Mount Holyoke College.

DR. JOHANNES WALTHER, professor emeritus of geology and paleontology at the University of Halle, died on May 3 at the age of seventy-seven years. In 1927 Dr. Walther spent several months in the United States as visiting professor at the Johns Hopkins University and at Columbia University.

ADMIRAL GOTTFRIED HANSEN, of Copenhagen, a member of the Arctic expeditions of Roald Amundsen, died on May 27. He was sixty-one years old.

A CIRCULATING library has been established at the Central Maine General Hospital, Lewiston, through a grant of the Bingham Associates, in honor of the late Dr. Frederic Henry Gerrish, formerly professor of anatomy at Bowdoin College Medical School, Portland. Material in the library, which now contains seventy-five journals, together with a large collection of reprints, will be available to all members of the State Medical Association.

SCIENTIFIC NOTES AND NEWS

THE Research Corporation of New York has awarded, through the Stevens Institute of Technology, plaques and the sum of $2,500 each to Professor Percy W. Bridgman, of Harvard University, and to Professor Ernest O. Lawrence, of the University of California, in recognition of their research in physics. The presentation was made at a dinner in New York City, presided over by Elon Huntington Hooker, chairman of the executive board of the Research Corporation, at which Dr. Harvey N. Davis, president of Stevens Institute, and Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, were the speakers.

AT the hundred and eighty-third commencement of Columbia University on June 1 the degree of doctor of science was conferred on Dr. John Howard Northrop, member of the Rockefeller Institute for Medical Research, and on Robert Broom, keeper of anthropology and vertebrate paleontology of the Transvaal Museum, Pretoria.

CLARK UNIVERSITY on June 5 conferred the honorary degree of doctor of science on Dr. H. H. Donaldson, member of the Wistar Institute of Anatomy and Biology, Philadelphia.

THE degree of doctor of science will be conferred on June 14 at the commencement of the Ohio State University on Dr. Charles Felton Scott, professor emeritus of electrical engineering at Yale University. He is a son of the late Dr. William Henry Scott, third president of the university, and a brother of the Rev. Dr. Herbert Scott, Pittsburgh, Pa., who will give the baccalaureate sermon on June 13.

FRANKLIN AND MARSHALL COLLEGE on June 2 conferred the doctorate of science on Dr. Frank Clifford Whitmore, dean of Pennsylvania State College.

ON May 31, Kansas State College conferred the honorary degree of doctor of science on Miss Flora Rose, '04, now director of the College of Home Economics at Cornell University, and on Dr. F. C. Sears, '92, emeritus professor of pomology at the Massachusetts State College.

DR. EDWARD A. BOYDEN, professor of anatomy at the University of Minnesota, was awarded the gold medal of the Southern Minnesota Medical Association for the best scientific exhibit at the annual meeting of the Minnesota State Medical Association, held in St. Paul on May 3. The medal was presented by Dr. A. W. Adson, of the Mayo Clinic, the retiring president of the association. Honorable mention was given to Dr. L. F. Hawkinson for endocrine studies and to Dr. Horace Newhart for his work on the prevention and amelioration of deafness.

ABOUT two hundred friends and colleagues of Professor W. J. Fraser honored him at a dinner on May 21. Professor Fraser will retire from active work in the University of Illinois at the close of the present academic year with the rank of professor emeritus. He was graduated from the University of Illinois in 1893 and in 1896 founded the department of dairy husbandry.

AUSTIN H. CLARK, of the U. S. National Museum, was authorized by an Act of Congress passed by the House of Representatives on June 1 and by the Senate previously to accept the Cross as a Knight of the Order of Dannebrog conferred upon him by the King of Denmark and Iceland.

DR. J. C. TH. UPHOF, of Orlando, Fla., was recently elected a corresponding member of the Dendrological Society of the Netherlands.

DR. OTTO HAHN, director of the Kaiser Wilhelm Institute for Chemistry and professor of chemistry at the University of Berlin, has been elected a corresponding member of the Bavarian Academy of Sciences.

OFFICERS of the North Central Branch of the Society of American Bacteriologists at the recent meeting in Madison, Wis., were elected as follows: Dr. William C. Frazier, of the department of agricultural bacteriol-

ogy of the University of Wisconsin, *president;* Dr. Max Levine, Iowa State College, *vice-president,* and Lyle A. Weed, University of Iowa, *secretary-treasurer.*

THE Columbia Chapter of Sigma Xi has elected the following officers to serve from June 1, 1937, to May 31, 1939: Professor Harold W. Webb, *president;* Professor Arthur W. Thomas, *vice-president,* and Professor Dana P. Mitchell, *secretary-treasurer.*

DR. T. S. PAINTER, professor of zoology at the University of Texas, has been appointed research professor for 1937–38. Dr. E. H. Sellards, professor of geology and director of the University Bureau of Economic Geology, held the position in 1936–37. This appointment is made each year by the board of regents on the basis of distinguished work. According to custom, Dr. Painter will deliver in the spring a series of lectures either of general or of technical interest embodying the results of his research.

DR. DAVID HILL TENNENT, head of the department of biology at Bryn Mawr College, has been appointed research professor for a five-year term. This is the first full-time professorship with no teaching duties at Bryn Mawr College. It has been made possible by a recent gift to the college.

PROFESSOR HENRY H. W. KEITH, of the Massachusetts Institute of Technology, has been appointed head of the department of naval architecture and marine engineering.

DR. PETER VAN DE KAMP, of the Leander McCormick Observatory of the University of Virginia, has been appointed associate professor of astronomy at Swarthmore College and director of the Sproul Observatory.

DR. G. R. WENDT, of the University of Virginia, has been appointed assistant professor of psychology at the University of Pennsylvania.

DR. VICTOR WEISSKOPF, of Copenhagen, who has been for the past several years a research assistant to Professor Niels Bohr and who had previously served in the same capacity with Professor W. Pauli at Zurich, has been made instructor in physics at the University of Rochester.

DR. THOMAS B. MAGATH, of the Mayo Clinic, has become health officer of the city of Rochester, Minn. He succeeds Dr. Charles H. Mayo, who has been health officer for the past twenty-five years.

PROFESSOR GURTH WHIPPLE, acting director of forest extension at the New York State College of Forestry, Syracuse, has been promoted to the position of director, succeeding the late Professor Frank B. Myers, who died on February 14.

PROFESSOR BERWIND P. KAUFMANN, head of the department of botany at the University of Alabama, has resigned to join the staff of the Department of Genetics of the Carnegie Institution of Washington at Cold Spring Harbor, N. Y., where he has been visiting investigator on leave of absence since February. He will continue his work on the cytology of Drosophila in cooperation with Dr. M. Demerec, assistant director of the department of genetics.

DR. E. M. LINDSAY, assistant at the Harvard Observatory in Bloemfontein, South Africa, has been appointed astronomer at Armagh Observatory, Ireland.

RENE GOVEIL, formerly of the Dominion Entomology Service at Ottawa, has been named chief entomologist of the Quebec Department of Lands and Forests.

DR. E. B. WORTHINGTON, of the University of Cambridge, has been appointed director of the laboratory of the Freshwater Biological Association of the British Empire. The association maintains a laboratory at Wray Castle on Windermere in which investigations are carried out on the zoology and botany of fresh waters.

DR. J. S. PLASKETT, director emeritus of the Dominion Astrophysical Observatory, Victoria, B. C., has returned from a three weeks' visit to Cleveland. There, in his capacity as scientific consultant of the Warner and Swasey Company, he has been observing progress and consulting on methods in the figuring of the 82-inch mirror for the McDonald Observatory in Texas.

DR. ERNEST O. LAWRENCE, of the University of California, delivered on May 10 the annual address to the University of Cincinnati Chapter of Sigma Xi, on "Atoms, New and Old."

DR. OSCAR RIDDLE, of the Carnegie Institution, Station for Experimental Evolution, Cold Spring Harbor, N. Y., on April 27 addressed the Ohio State University Chapter of Sigma Xi on "The Hormones of the Anterior Pituitary Gland."

DR. L. C. GRATON, professor of mining geology at Harvard University, gave the address at the annual meeting on May 18 of the Harvard Chapter of Sigma Xi. The subject treated was "Controversies Regarding the Origin of Ores."

PROFESSOR C. L. METCALF, head of the department of entomology at the University of Illinois and president of the Illinois Chapter of Sigma Xi, gave the address entitled "The Morbific Triangle" at the annual meeting on May 13 of the College of Medicine Chapter in Chicago.

DR. G. W. MCCOY, medical director of the U. S. Public Health Service, Washington, D. C., addressed the members of the Dugas Journal Club of the School of Medicine of the University of Georgia on May 17.

Dr. McCoy discussed the relationship of epidemiology to public health.

SIR HENRY DALE, director of the National Institute for Medical Research, Hampstead, London, was the guest speaker on May 18 at the Academy of Medicine of Washington, D. C. Dr. Dale spoke of his researches into the mechanisms of transmission of excitation from nerve ending to end organ. The address was preceded by a dinner at which announcement was made of the election of Dr. Dale to honorary membership in the academy.

THE next annual meeting of the American Society of Zoologists will be held in Indianapolis on December 28, 29 and 30 in association with Section F of the American Association for the Advancement of Science. All sessions for the reading of papers and for demonstrations will be held at the Indiana University School of Medicine. Titles and abstracts of papers and demonstrations to be presented by members of the society should be sent to the secretary, E. G. Butler, Princeton University, Princeton, N. J., before November 8.

THE summer meeting of the Genetics Society of America will be held at Woods Hole on August 31 and September 1. On the evening of August 30 a lecture will be delivered by Dr. Boris Ephrussi, of the Institut de Biologie Physico-Chimique, Paris. Two sessions of the program will be devoted to round table conferences on different methods of study as applied to problems of genetics. These conferences are being organized by Professor L. C. Dunn, who will act as leader in the discussions. The different topics will be introduced by: W. Landauer, E. W. Sinnott, H. B. Tukey, D. F. Poulson, B. Ephrussi, E. Hadorn, M. Demerec and others. One session has been reserved for demonstration papers.

THE Carolina Geological Society was formed by a group interested in earth sciences, meeting at the invitation of Professor W. C. Holland, of the department of geology of Furman University, Greenville, S. C., on May 15. The object of the society is to promote the sciences of geography, geology, metallurgy, mining, ceramics and soil science in North and South Carolina. It was decided to hold annual field trips of from one to two days each autumn. Professor W. C. Holland was elected *president;* Berlen C. Moneymaker, of the Tennessee Valley Authority, Murphy, N. C., *vice-president,* and Professor Willard Berry, Duke University, *secretary-treasurer.* Professor G. R. MacCarthy, of the University of North Carolina, was elected chairman of the membership committee.

THE Rocky Mountain Biological Laboratory at Crested Butte, Colo., will be opened on June 28 to enable biologists who attend the Denver meeting of the American Association for the Advancement of Science to leave immediately afterwards for a visit, or for a longer period of investigation, study and recreation. A three-day excursion to the laboratory, beginning on Sunday, June 27, is being arranged from Denver. The cost of the trip will be approximately $12.00, including lodging (3 nights), meals and transportation by auto, covering in the round trip some 570 miles in the heart of the Rockies. The laboratory centers its activities around problems of the alpine and subalpine regions. Those wishing to take part in the excursion should communicate with the director of the laboratory, Dr. John C. Johnson, Pennsylvania State Teachers College, West Chester.

THE *Journal* of the American Medical Association reports that under the recent reorganization of the Scientific Research Division of the U. S. Public Health Service, effective on February 1, three new divisions were established at the National Institute of Health: the division of biologic control under the direction of Senior Surgeon Walter T. Harrison; the division of public health methods, which incorporates the work of the former field office of public health methods with the work of the offices of child hygiene, milk investigations, statistical investigations and the laboratory of stream pollution investigations, under the direction of Surgeon Joseph W. Mountin, and the division of industrial hygiene, which coordinates the work of the former office of industrial hygiene and the extensive laboratory studies of occupational dermatoses carried on at the National Institute of Health, under the supervision of Senior Surgeon Royd R. Sayers. The former division of bacteriology and pathology was further reorganized so that part of the division relating to bacteriology is known as the division of infectious diseases. Under the direction of Senior Surgeon Rolla E. Dyer, this division covers the field and laboratory work relating to infectious diseases, including leprosy studies, malaria investigations, the Rocky Mountain Laboratory, tuberculosis and epidemiologic studies. The division of pathology now includes the field office of cancer investigations. The former divisions of chemistry, pharmacology and zoology of the institute remain under the direction of Drs. Claude S. Hudson, Carl Voegtlin and Maurice C. Hall, respectively.

AN expedition to the Pribilof Islands in the Bering Sea, off the coast of Alaska, to collect fur seals for a projected habitat group for the Field Museum, Chicago, is leaving early in June. It is planned to collect more than thirty specimens of both sexes and of various ages. The group, illustrating the "home life" of the animals, will reproduce a rookery or breeding ground. It will be installed in the Hall of Marine Mammals. The leader of the expedition, C. J. Albrecht, taxidermist, who worked in the same region a

number of years ago, will spend the greater part of the summer in the islands, living among the native Aleut inhabitants.

A WIRELESS dispatch from Berlin to *The New York Times* reports that in the presence of Chancellor Adolf Hitler the Reich Research Council was inaugurated on May 25. National Socialist Cabinet members and a large body of scientific men attended. The new organization was created especially to further the four-year plan. Minister of Education Bernhard Rust explained that technical and natural science research would be pursued systematically by the council, Germany's economic self-sufficiency being the objective. General Karl Becker outlined the principal departments of the new institution as follows: physics, chemistry and physical chemistry, automotive power, rubber, textiles, fats, cellulose, non-ferrous metals, mineralogy, geology, biology, including zoology and forestry, the technical side of defense research, electrotechnic mining, iron and steel, medical research and preventive medicine.

DISCUSSION

STYLISTIC INFELICITIES AND THE EXCESS WORD

MR. URBACH, of the department of English and history of the Massachusetts Institute of Technology, recently[1] has complained about the bad writing manners of "a great many American scientists." He is particularly aggravated about "stylistic infelicities," "excess words," circumlocutions and mixed metaphors, of which he gives a number of examples "from the current writings of scientists." Perhaps because these examples were all taken from the writings of social and biological scientists, the pertinent comments to date have been limited to one from a psychologist[2] and another from a botanist.[3]

Any one who has had to correct theses in the making is apt to lend a sympathetic ear to Mr. Urbach's complaints. But in reading the works of most full-fledged physical and biological scientists one is constantly amazed not that they write so poorly, but rather that they express themselves so well. It is true that some have a minor genius for mixing metaphors, yet few have produced such classics as, "I smell a rat, I'll nip it in the bud." And even the Bard of Avon did not lose his reputation when he wrote: "to take arms against a sea of troubles." Furthermore, however common or reprehensible may be *such* "stylistic infelicities" in scientific writing, the average scientist is not a habitual criminal when it comes to the sin of the *"excess word."* Not only is he likely to express himself succinctly, but, if he errs, there are the watchful editors of scientific journals to insist that the verbose mind their verbiage and to urge the commonly curt to become more consistently concise. There is a deluge of scientific papers submitted for publication, and a dearth of journals wherein they may be printed. So that, instead of the truly classical writings of some of the older scientists, we now of necessity can have only a sort of scientific shorthand which should be criticized not for the "excess word," but for the excised phrase.

We are all professionals at finding fault with our colleagues' writings, but we are tyros at correcting our own; nevertheless, since Mr. Urbach brought up this matter of the "excess word," perhaps he will permit us to examine his note in the light of his own criticism. He began:

"During the last six months I have analyzed from the point of view of their composition perhaps fifty scientific articles. My survey (if merely red-penciling errors and stylistic infelicities may be so dignified) was startling in its revelation of how badly a great many American scientists do write." Few real scientists would venture to express themselves in such a prodigal fashion. Many would have written:

"An analysis of the composition of some fifty scientific articles reveals how badly a great many American scientists write." And some editors would even blue pencil four of the nineteen words surviving out of the original forty-nine.

Mr. Urbach continued his discussion with two juicy paragraphs from which the average scientific writer could squeeze a veritable stream of "excess words," before he even arrived at his stated consideration of the crime of wordiness as illustrated by the writings of a number of scientific culprits. He began his treatment of the subject:

"Nothing makes for more cumbersome, pedantic writing than the use of unnecessary words." Nine of these very words are certainly unnecessary. Most scientists would write:

"Unnecessary words make cumbersome writing." And there are some disgruntled writers who would insist that scientific editors, with their fine disregard for context, might feel that even "Words make writing" was sufficient.

Mr. Urbach then goes on to cite another horrible example of the "excess word," apparently from the writings of some unsuspecting political scientist, concerning whose efforts he says:

"The italicized words boil down to 'undoubtedly

[1] W. F. Urbach, SCIENCE, 84: 390–391, October 30, 1936.

[2] E. G. Boring, SCIENCE, 84: 457–459, 1936.

[3] H. W. Rickett, SCIENCE, 85: 45–46, 1937.

because'; the two sentences become one. Of the fourteen words, twelve are unnecessary. Perhaps even the last phrase, 'to be reckoned with,' is a bit superfluous, too."

Translated into the language of the scientist the "excess words" are removed and there results:

"Since the italicized words mean 'undoubtedly because,' twelve are unnecessary. Even 'to be reckoned with' is superfluous." But of course we are belaboring the point. Almost any paragraph or sentence can be condensed, but commonly such reduction engenders rather than aborts "stylistic infelicities," and it usually plays havoc with the original thought as well. Nevertheless, in this day, when the scientist is blamed for most every excess under the sun, it may be well to insist again that he is not generally guilty of "excess words." True, he may not be a hardened criminal simply because he can't help himself. For instance, a recent number of the *Bulletin* of the Geological Society of America contained seven important descriptive papers, all of which had been thoroughly revised by the editorial board. Each had been materially reduced of the "excess word," the longest by as much as 42 per cent., or from 104 pages of manuscript to 60. Moreover, were this particular journal not heavily subsidized, papers of more than 20 pages, however important, probably would rarely be accepted. In the fields of chemistry, physics and mathematics the situation is still more acute, for even epoch-making discovries must be reported on a printed page or two. Instead of "excess words" in such papers there unfortunately may be almost no words at all.

To-day, when politicians, political and social scientists, novelists, administrators and reformers are all wallowing in a plethora of ambiguous words, it is an anomalous situation that many concise, unequivocal scientific statements of some real consequence remain unpublished. Therefore, although I admit both the general validity and value of Mr. Urbach's criticisms, I suggest that if he is really looking for the "excess word" he turn from scientific writings to more likely sources. He might delve into the *Congressional Record*, a metropolitan apartment lease, an income tax form, the public utterances of high officials or a certain novel which requires a thousand pages to portray what General Sherman, a scientifically trained soldier, aptly described in three words.

CAREY CRONEIS

WALKER MUSEUM,
UNIVERSITY OF CHICAGO

HAS UTAH LOST CLAIM TO THE LOWER SONORAN ZONE?

FEW spots in the West have aroused more interest in the student of plant and animal distribution than a restricted area in the vicinity of St. George, Utah, located in the extreme southwestern corner of the state. The unusualness of this locality lies in the fact that it is a typical Covillea belt of approximately 350 square miles, surrounded on all sides by cold temperate flora except for a narrow, continuous strip of Lower Sonoran vegetation extending along the Virgin River through southern Nevada.

The St. George area has for centuries represented an extreme northern tongue of the southern desert shrub type. In October, 1776, Father Escalante described the presence of mesquite and numerous flowers blooming along the streams in the vicinity of St. George and contrasted the weather here with the bitterness of winter which he encountered but a few miles to the north. Brigham Young in 1850, realizing the semi-tropical nature of the locality, directed the immediate settlement of Utah's Dixie for the expressed purpose of growing cotton. In this part of the state the settlers grew not only cotton successfully, but also semi-tropical fruits, such as figs, pomegranates and grapes of various varieties.

Since the establishment of a weather station at St. George in 1890 sub-zero weather has been experienced in only three winters. On January 2, 1901, a low of -1° F. was recorded, but this extreme was of short duration and no damage to cultivated crops or native vegetation apparently resulted. During the winter of 1909, when low temperatures of - 4° F. were recorded for three consecutive days, December 25, 26 and 27, figs and pomegranates were damaged considerably, but the native vegetation seemed to escape noticeable injury. January, 1937, brought the lowest and most extended duration of extreme temperature ever known in the St. George area. The following lows with dates appear in the weather bureau records: Jan. 21 -9° F., Jan. 22 -11° F., Jan. 23 -1° F., Jan. 24 -2° F., Jan. 25 -1° F., Jan. 26 -11° F., Jan. 27 -7° F. Wide-spread destruction to tender varieties of grapes, figs and pomegranates is now evident, and the chief plant indicators of the Lower Sonoran Zone, such as *Covillea tridentata* and the two mesquites, *Strombocarpa odorata* and *Prosopis glandulosa*, appear to be dead. Whether or not some of this native vegetation will throw new shoots later remains to be seen, but brown, water-soaked cambium layers even at the crown of most shrubs observed throws doubt on this possibility.

Aside from the suddenness with which vegetation may be eliminated from a rather considerable area, the tragedy of this prank of nature has definite bearing on the fundamental concepts of the factors of climate governing plant distribution. Especially does this wide-spread destruction of vegetation due to continued low temperatures emphasize the inadequacy of Merriam's theory of zonation in its failure to take into

consideration temperature data of the dormant period. That the long duration of low extremes of temperature may be a critical factor in the wide-spread destruction of vegetation is further substantiated by the fact that the juniper of the upper limits of the Upper Sonoran Zone of southern Utah are bronze in appearance because of the rigors of the past winter. Whether repopulation of these damaged areas will be accomplished by means of seeds ripened last fall or whether a general altitudinal lowering of these vegetation zones will result, only time will tell.

WALTER P. COTTAM

UNIVERSITY OF UTAH

REGENERATION OF ULTRACENTRIFUGED ADRENAL TISSUE IN THE ALBINO RAT

IN a previous paper[1] the writer reported the cytological changes produced in rat adrenal cells by ultracentrifuging at 400,000 times the force of gravity. Briefly, such cells show marked stratification of their components according to relative specific gravity and the viscosity of the medium. In order to determine the capacity of these cells to retain their viability, to reconstitute, regenerate and function normally, autoplastic grafts have been made.

A significant series of rats averaging 50 days age were doubly adrenalectomized, a portion set aside as controls, and the remainder used for transplanting. In the latter group the excised glands were ultracentrifuged for 30 minutes, thereby producing maximum stratification, as described in the paper already referred to. These were then halved and two or three pieces grafted autoplastically into pockets cut into the abdominal muscles. Both the control and the transplanted rats were placed on a salt diet to guarantee a sufficient survival period in which the grafts might "take." After about 30 days the animals were returned to a normal diet to check the efficacy of the implants. Up to the present time (three months after adrenalectomy of the first lot) none of the implanted rats have died, except for a few whose death during the first 72 hours could be attributed to traumatic shock. On the other hand, most of the control animals (doubly adrenalectomized, but without implants) failed to survive even the first 30 days on salt diet. At the present writing some of the implanted animals have been killed, the grafts excised and serially sectioned, and thorough search made for accessory adrenal tissue which included serial sectioning of the original adrenal sites. In the cases so far examined no accessory tissue has been found; however, the ultracentrifuged implants show excellent and abundant regeneration of cortical tissue, but no medullary cells. Cytologically, the cortical cells appear normal, though certain differences in the histological arrangement are apparent. More detailed studies are in progress.

It appears, therefore, that the severe centrifugal displacement of cytological elements in adrenal cortical cells does not hinder these cells from reconstituting, regenerating and performing their normal physiological functions. A complete and detailed account of this work is in preparation and will be published elsewhere.

ERNST J. DORNFELD

DEPARTMENT OF ZOOLOGY
UNIVERSITY OF WISCONSIN

[1] Dornfeld, *Anat. Rec.*, 65: 403, 1936.

ABUNDANCE OF THE EUROPEAN STARLING IN ILLINOIS

SINCE its first appearance in Illinois, about fifteen years ago, the European starling has steadily increased in numbers until it may now be considered a pest almost equal to that of the English sparrow. When first noted in Champaign County by Professor Frank Smith and the writer (1922), it was always observed in company with grackles, never in flocks by itself.

During several motor trips about the state the past winter this bird was observed in certain places in great abundance. On March 7, while passing over route 24 from Peoria to Forrest, eight flocks of starlings were noted, none of which contained less than 100 birds in each flock. The flock was pure starling, no grackles being noted in this part of the state at this time of year. Going south on route 47 from Forrest to Mahomet seven flocks of starlings were noted, each flock estimated to contain at least 75 birds. An estimation of the total number of starlings seen on these two routes on this day gives over 1,300 birds. When the automobile passed the flock the birds rose in a great cloud.

On March 8 and on April 4 trips were taken over route 10 to Decatur and over route 36 to Springfield and no starlings were observed. This area is south of that upon which the large flocks were seen.

Several years ago an attempt was made to reduce the immense numbers of the purple grackle which infest the city of Urbana, and the police department shot at evening time into several flocks which were preparing to roost for the night. Several hundred were killed, but there was not a starling among them. But, curiously enough, there were many cowbirds; perhaps the flocks may have contained 15 per cent. of this species. As there were no starlings it seems evident that this species is here in sufficient numbers to flock by itself and does not mingle with the grackles as formerly.

FRANK COLLINS BAKER

MUSEUM OF NATURAL HISTORY
UNIVERSITY OF ILLINOIS

SOCIETIES AND MEETINGS

THE IOWA ACADEMY OF SCIENCE

THE fifty-first annual meeting of the Iowa Academy of Science was held at the University of Dubuque and Columbia College in Dubuque on April 16 and 17, with 212 members and visitors in registered attendance.

The presidential address, "Education and Industry," was presented by Dr. L. P. Sherman, professor of chemistry at Grinnell College. Other papers of general interest were "The Flow of Water in Unsaturated Soils" by Dr. L. A. Richards, of Iowa State College, and "The Mammals of Iowa," by Dr. Roy L. Abbott, of the Iowa State Teachers College. Dr. A. J. Carlson, professor of physiology at the University of Chicago, represented the American Association for the Advancement of Science at this meeting and also gave the annual address. His subject was "Studies on the Mechanisms of Hunger, Appetite and Thirst."

The following general officers were elected for 1937–38:

President, A. C. Trowbridge, State University of Iowa; *Vice-president*, J. N. Martin, Iowa State College; *Secretary-Treasurer* and *American Association for the Advancement of Science Representative*, J. C. Gilman, Iowa State College; *Editor*, Mrs. F. W. Nichols, Ames; *Executive Committee*, W. C. Oelke, Grinnell College, and E. E. Emme, of Morningside College. Section chairmen were elected as follows: *Botany and Bacteriology*, F. B. Smith, Iowa State College; *Chemistry, general and physical*, James A. Coss, Morningside College; *Chemistry, organic and biological*, Otto Nitz, Parsons College; *Geology*, Louise Fillman, Simpson College; *Mathematics*, L. E. Ward, State University of Iowa; *Physics*, William Kunerth, Iowa State College; *Psychology*, Robert Leeper, Cornell College; *Science Teaching*, S. M. Dietz, Iowa State College; *Zoology*, George Huff, Drake University.

The academy convened in eight sections for the presentation of 112 papers of special interest. A new section on science teaching was organized. The Junior Academy of Science of Iowa met with the academy and at the Dubuque Senior High School. Forty delegates from 14 clubs were present. The total registered attendance was 180. Dr. D. W. Morehouse, of Drake University, Dr. R. L. Abbott, of Iowa State Teachers College, and Dr. J. A. Eldridge, of the State University of Iowa, were speakers on the program.

J. C. GILMAN,
Secretary-Treasurer

THE TENNESSEE ACADEMY OF SCIENCE

THE spring meeting of the Tennessee Academy of Science was held on May 7 and 8 at Southwestern University, Memphis, Tenn. The program included "Welcome to Southwestern" by the president, Dr. Charles E. Diehl, papers at three general sessions and at a special session of members interested primarily in physics, a dinner on Friday evening and "Demonstrations."

About three fourths of the papers were by members of the faculty and advanced students of Memphis and Nashville schools. Four departments of the University of Tennessee Medical School were represented: Pharmacology, J. B. Mitchell, Jr., "Biology of the Black Widow Spider"; Physiology, J. Victor Monk, "Nature and Significance of Phasmaphaeresis"; Histology, D. S. Pankratz, "Foetal Movements in Rabbits"—a colored motion picture; Medicine, L. A. Diggs, "Sickle Cells Anemia."

The Botany Section, having planned "a botanical foray in the Smoky Mountains" for June, did not hold a special meeting. However, the chairman of the section, Dr. Jesse M. Shaver, was present as usual with a number of beautiful pictures of wild flowers and ferns; and with a specialized camera at hand he showed how he had made them.

At the meeting of the physicists Dr. Peyton N. Rhodes, vice-president of the academy, who presided, exhibited several interesting lecture-table demonstrations, four papers were read and a committee was appointed to apply to the academy for the formation of a physics section.

Mr. F. W. Brist, chief of the U. S. Weather Bureau, Memphis, made an address at the dinner on Friday evening at the Peabody Hotel on the subject, "Weather and the Public."

The "Demonstrations," which included live specimens of thirty-six species of reptiles and amphibia of Reelfoot Lake collected by Malcolm V. Parker, of Southwestern University, was a unique and interesting feature of the Memphis meeting.

Dr. C. L. Baker, director of the Reelfoot Lake Biological Station, stated plans for research work to be carried on there next summer.

The next meeting of the academy will be held on November 26 and 27 at Nashville. Dr. McGill will represent the academy at the meeting of the American Association for the Advancement of Science and the Conference of State Academies of Science at the meeting in Indianapolis next December.

JOHN T. MCGILL,
Secretary

THE SOUTH CAROLINA ACADEMY OF SCIENCE

THE fourteenth annual meeting of the South Carolina Academy of Science was held at the University of South Carolina, Columbia, S. C., in joint session with

the South Carolina Section of the American Chemical Society and the South Carolina Section of the Southern Society for Psychology and Philosophy, on Saturday, May 1, 1937. More than two hundred members attended.

The morning session was devoted to papers of more general interest and the address, "The Ubiquitous Insect," of the retiring president, Professor Franklin Sherman, of Clemson College. The afternoon session was divided into sections of biology and chemistry.

At the business session the following officers for 1937–38 were elected:

President: Dr. J. E. Mills, Sonoco Products Company, Hartsville, S. C.
Vice-president: Dr. G. G. Naudain, Winthrop College, Rock Hill, S. C.
Secretary-Treasurer: Dr. F. W. Kinard, Medical College, Charleston, S. C.
Curator: Dr. J. E. Copenhaver, University of South Carolina, Columbia, S. C.
Editor: To be appointed.
Executive Committee: Professor A. C. Carson, University of South Carolina; Professor Franklin Sherman, Clemson College; Dr. C. B. Waller, Wofford College; Dr. Velma Matthews, Coker College; Dr. J. C. Kinard, Newberry College.

The Jefferson Medal for the outstanding paper was awarded to Dr. Roe E. Remington, of the Medical College, for a paper entitled "A Quantitative Technique in the Study of Goitre." The 1937 Research Fund was granted to Drs. J. Hampton Hoch and Hillyer Rudisill, Jr., of the Medical College.

The next meeting will be held in the spring of 1938 at Charleston, South Carolina.

F. W. Kinard,
Secretary

SPECIAL ARTICLES

ON THE STRUCTURE OF INSULIN

It has recently been shown[1] that the cyclol theory of protein structure,[2] originally developed with special reference to the structure both of unimolecular protein films[3] and of the multi-laminar proteins, logically implies the existence of "space-enclosing" protein molecules; these contain certain specific numbers of amino acid residues. In particular a certain series of space-enclosing cyclols $C_1, \ldots C_2, \ldots C_n, \ldots$ which comprise $72, 288, \ldots 72n^2, \ldots$ amino acid residues have been constructed. The theory thus passes the test, to which any theory of protein structure must submit, of predicting in general terms the body of facts relating to the "globular" proteins established by Svedberg and his collaborators.[4]

In view of the fact that considerable data relating to insulin are now available, including the x-ray analysis of the structure of insulin crystals,[5] it was deemed worth while to investigate in detail how far any of these space-enclosing cyclol molecules which have now been constructed can be used as a basis for a discussion of the structure of insulin. The molecular weight of insulin is known accurately enough for it to be plain that C_1 is much too light and C_3 much too heavy. The only cyclol of the series which comes into question is therefore C_2. Here the number of residues is of the right order of magnitude.

Each space-enclosing molecule consists of a piece of the cyclol fabric shown in Fig. 1, which by bending

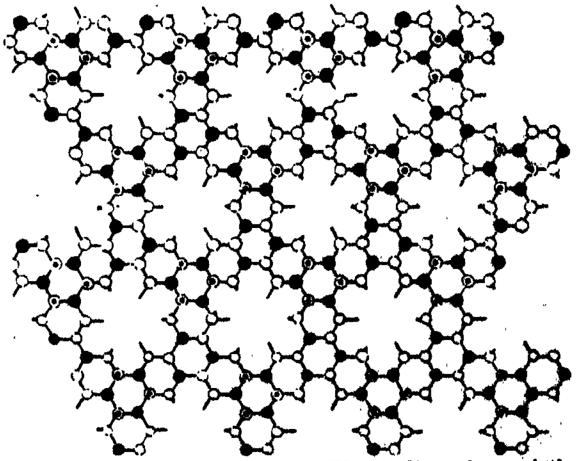

Fig. 1. The cyclol pattern. The median plane of the lamina is the plane of the paper. The lamina has its "front" surface above and its "back" surface below the paper.

● = N.
○ = C(OH), peptide hydroxyl upwards.
⊙ = C(OH), peptide hydroxyl downwards.
○— = CHR, direction of side chain initially outwards.
○- = CHR, direction of side chain initially upwards.

across one line after another joins up and so surrounds a portion of space. For simplicity of exposition, the cyclol fabric may be replaced by its median network in which the C-C-N atoms in the constituent residues are replaced by points midway between linked atoms. Various views of a model of the median network of the molecule C_2 are shown in Fig. 2. This network lies on the surface of a truncated tetrahedron and

[1] D. M. Wrinch, *Nature*, 139: 1937 (in the press).
[2] D. M. Wrinch, *Nature*, 137, 411; 138, 241 and 651; 1936. *Proc. Roy. Soc. Lond. A.*, 160: 59, 1937.
[3] I. Langmuir, V. Schaefer and D. M. Wrinch, Science, 85: 76, 1937.
[4] T. Svedberg *et al.*, *Koll. Z.*, 51: 10, 1930. *Trans. Far. Soc.*, 26: 72 and 737, 1930. Science, 79: 327, 1934. *Biol. Bull.*, 66: 191, 1934. *Chem. Rev.*, 14: 1, 1935, and a series of papers in *Jour. Am. Chem. Soc.*, from 1929.
[5] D. Crowfoot, *Nature*, 135: 591, 1935.

possesses four triangular faces and four hexagonal faces. This polyhedral configuration is in agreement with Svedberg's deduction that insulin is a "globular"

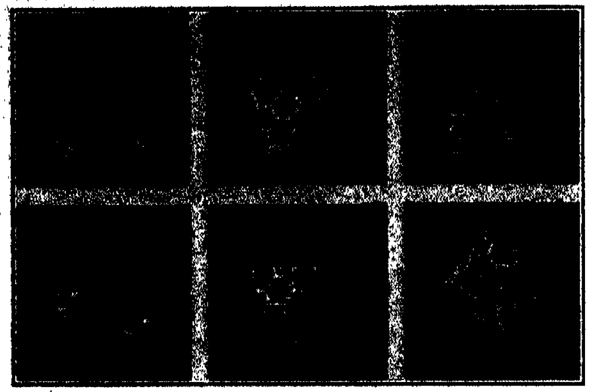

FIG. 2

molecule with low asymmetry number[6] and in fact offers an interpretation of the nature of this "globularity," which may be useful in the future in a quantitative interpretation of the asymmetry numbers of megamolecules in general. Further, since the C_2 structure (like all C_n structures) is a condensation of amino (or imino) acid molecules, no prosthetic group is required, in accordance with the chemical evidence.

The most stringent test of any proposed structure is afforded by the x-ray findings.[5] In the first place the insulin lattice has space group R3, and the unit cell is rhombohedral and contains one molecule only. Strictly interpreted, this means that the molecule itself has trigonal symmetry. Now for all the space-enclosing cyclols, the median network (which is to be regarded as a shorthand notation for the molecular structure, from which its essential features can be deduced) has four trigonal axes, if the distribution of different amino acids be left out of account. This symmetry requirement can then be met by any C_n and at the same time interpreted to mean that in the insulin molecule one hexagonal and one triangular face have the various residues trigonally arranged, while the three other hexagonal faces and also the three other triangular faces have identical arrangements of residues.

Next, the unit rhombohedral cell has a = 44.3A and $\alpha = 115°$. On working out the detailed geography of the structure proposed, it is found that the cyclol molecule C_2 (whose median network is shown in Fig. 2) fits easily and elegantly into this cell; furthermore, its structure suggests actual mechanisms of coordination in this megamolecular lattice. Thus the coordination between a molecule and its neighbors above and below at a distance 30.2A along the trigonal axis appears to be due to the simultaneous linking of a number of peptide hydroxyls. On the other hand each molecule appears to be linked severally to its six neighbors at distances 44.3A along the edges of the primitive rhombohedron by means of groups belonging to side chains, probably by the phenolic groups of tyrosine residues, which are held together by zinc (or other) cations. This mechanism accounts for the data of Scott which establish the fact that in insulin crystals there is a stoichiometric relation between the insulin content and the content of zinc, of cadmium or of cobalt.[7] The proportion is three cations to one molecule of insulin, which is in accordance with the mechanism of coordination suggested above, assuming that each insulin molecule has a half share of the six cations, located on the rhombohedral edges. The present suggestions thus fit in with and explain the view that crystalline insulin contains the metals as chemically combined constituents and not as mere impurities, and throws light also upon the fact[7] that the best acidity for the crystallization of insulin in the presence of certain metals is pH 6.0 to 6.2 on the alkaline side of the isoelectric point[8] pH 5.0 – 5.5.

Full details of the work will appear shortly.

D. M. WRINCH

MATHEMATICAL INSTITUTE
OXFORD

THE DIFFUSION COEFFICIENT AND MOLECULAR SIZE OF VISUAL PURPLE

IN order to secure some notion of the molecular dimensions of visual purple, we have determined its diffusion coefficient by the method of Northrop and Anson.[1] This involves measuring the rate with which a dissolved substance passes from an enclosed solution into an outer solvent through a porous glass or alundum disk calibrated with substances of known diffusion coefficient.

The two basic properties of visual purple are its color and its light sensitivity. We have therefore relied on these criteria for measuring its diffusion. Using three different glass disks and four preparations of visual purple, we have obtained apparent diffusion coefficients of 0.0153, 0.0125, 0.0161 and 0.0152, with an average of 0.0148 sq. cm. per day at 6° C.

These values are probably not the real diffusion coefficients, because the glass disks become clogged during the manipulations. The clogging happens rapidly and then stops; after diffusion equilibrium with visual purple has become established over night the rate usually remains constant for as long as we have measured it, in one case for a week.

To estimate this clogging factor we calibrated the disks as usual with 2 M NaCl before the visual purple

[6] T. Svedberg and I.-B. Eriksson-Quensel, *Tabulae Biologicae Periodicae*, 5: 351, 1935–36.

[7] D. A. Scott and A. M. Fisher, *Biochem. Jour.*, 29: 1048, 1935.

[8] F. O. Howitt and E. B. R. Prideaux, *Proc. Roy. Soc. Lond., B.*, 112: 13, 1932.

[1] J. H. Northrop and M. L. Anson, *Jour. Gen. Physiol.*, 12: 543, 1929.

was introduced into the diffusion cell; then the calibration was repeated after the establishment of a steady state of diffusion, with the visual purple still in the cell. With two preparations of visual purple the first calibration gives an average diffusion coefficient of 0.0156, while the second calibration makes it 0.0190 sq. cm. per day. The latter is probably more nearly correct, because the second calibration records the actual state of the disk during the diffusion of the visual purple.

Efforts to eliminate the clogging factor by using alundum disks were not satisfactory because they trapped air easily, and the individual determinations varied widely (from 0.0108 to 0.0177 sq. cm./day) even in a single run. However, the values are of the same order of magnitude as with the glass disks.

To derive the molecular size of visual purple from diffusion data involves the application of Einstein's[2] equation which relates the diffusion coefficient to the radius of the molecule by way of the coefficient of friction and Stokes's law. Such an application is quite reasonable,[3] provided one is interested only in an order of magnitude. Taking the diffusion constant as 0.0148 sq. cm./day, the equations yield 8.04×10^{-7} cm. as the radius of the molecule of visual purple; using the more probable value of 0.0190 sq. cm./day, the radius becomes 6.26×10^{-7} cm. Either of these values shows visual purple to be a large molecule of the size heretofore found only for proteins. Its molecular volume computed from the smaller and more probable radius is 623,000; and if its specific gravity is 1.3 like that of most proteins, its molecular weight is 810,000.

Molecular weights computed from diffusion coefficients are frequently higher, often by a factor of 2 or even 3, than those computed from osmotic pressure or sedimentation data. The real molecular weight of visual purple may therefore be half or even a third of the value here given. For our purposes, this is of minor importance because even so it would still be a very large molecule of the kind found only among the proteins.[4]

This is powerful evidence that visual purple is really a protein, and agrees with Kühne's[5] inability to separate visual purple from the neurokeratin of the rods, and with his demonstration of the high temperature coefficient of its thermal destruction. Adding Wald's contribution[6] that visual purple liberates a carotenoid when it is bleached by light or acted upon by chloroform, it definitely places visual purple among the conjugated proteins—the carotenoid proteins.

The visual purple solutions were prepared as previously described,[7] and were buffered with borate-KCl to a pH of 9. The glass disks of porosity 4G had a diameter of 30 mm and were about 0.5 mm thick. The inner diffusion cell contained 10 cc of visual purple solution, and the outer cell contained 7 cc of solvent—either digitonin or bile salts solution—also buffered to pH 9. When the disks were to be calibrated after the diffusion had reached equilibrium, NaCl was added at the beginning to both the visual purple and the outside solutions to make a concentration of 2 M; then when the diffusion rate had become constant, we determined the passage of the NaCl into an outer digitonin solution without NaCl. The entire apparatus was immersed in a water bath at 6° C. in a dark cold-room kept at the same temperature. The water bath was carefully mounted on rubber and then on a heavy concrete block to avoid undue vibration. The concentration of visual purple was determined with a photoelectric spectrophotometer, using as a measure the difference in photometric density at 500 mμ between the unbleached and subsequently bleached solution. The pH of 9 is to avoid any regeneration after bleaching. The experiments were made during the past year, and were aided by a grant from the Rockefeller Foundation.

SELIG HECHT
AURIN M. CHASE
SIMON SHLAER

LABORATORY OF BIOPHYSICS
COLUMBIA UNIVERSITY

RATE OF MATURATION OF YOUNG RED CELLS IN CANARIES

THE erythrocytes that are present in the peripheral blood of birds may be separated into three types, all of which are nucleated.

(1) Nucleated basophilic erythrocytes are spheroidal in shape, free from hemoglobin and stain only with basic dyes. The nucleus is large and spheroidal, and the chromatin is coarsely reticulated. Only a fraction of one per cent. of these occur in the peripheral blood of canaries.

(2) Nucleated amphophilic erythrocytes are spheroidal or elongate in shape, contain a small amount of hemoglobin and stain with either acid or basic dyes. The nucleus is large and oval in shape and the chromatin is present in the form of irregularly shaped clumps of various sizes; such nuclei are called polychromaphilic. Usually from one to 6 per cent. of these occur in the peripheral blood of canaries.

(3) Nucleated oxyphilic erythrocytes are spheroidal or elongate in shape, and contain hemoglobiniferous or oxyphilic cytoplasm. The nucleus is small, being

2 A. Einstein, *Z. Elektrochem.*, 14: 235, 1908.
3 M. L. Anson and J. H. Northrop, *Jour. Gen. Physiol.*, 20: 575, 1937.
4 T. Svedberg, *Trans. Faraday Soc.*, 26: 740, 1930.
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6 G. Wald, *Jour. Gen. Physiol.*, 19: 351, 1935.
7 S. Hecht, A. M. Chase, S. Shlaer and C. Haig, SCIENCE, 84: 331, 1936.

only about half as large as the nuclei in (1) and (2), and the chromatin is compact.

When stained by the Giemsa method, the cytoplasm of (1) and (2) is light blue or gray and that of (3) is light yellow or orange; the nucleus of (1) and (2) is a mottled purple, the reticulated chromatin and lumps of chromatin being clearly differentiated; the nucleus of (3) is a more or less uniform or homogeneous purple. Various stages intermediate between (1) and (2) and (2) and (3) occur.

Types (1) and (2) are considered to be "young red cells" and type (3) "old red cells." These young and old red cells are very easily distinguished from one another after being stained by the Giemsa method.

Several investigators have called attention to the fact that when the mature schizonts in the asexual cycle of certain species of malaria parasites of both man and birds undergo segmentation, the merozoites attack young red cells more readily than they do old red cells. The approximate rate of maturation of young red cells after they are liberated into the peripheral blood of the canary can be determined by observing the comparative age of the red cell and of the growing malaria parasite within it. *Plasmodium cathemerium* was used for our determinations. The merozoites of this species enter young red cells and the schizonts into which they develop grow to maturity in 24 hours; then they segment, giving rise to a new litter of usually from 12 to 20 merozoites. Synchronicity in the segmentation of *P. cathemerium* is pronounced; most of the schizonts segment in the early evening hours. At 10 P.M. most of the recently produced merozoites are present in young red cells. A few hours later the trophozoites have become obviously larger and the red cells have changed from stages (1) or (2) in the direction of stage (3). By the end of 21 hours, that is, at 7 P.M. on the succeeding day, only mature schizonts are present, and these are all in mature red cells. The conclusion reached is that the young parasitized red cells become mature within a period of 21 hours. The percentages of merozoites and mature parasites in young and old red cells obtained from a study of three birds are given in Table 1.

TABLE 1

Bird	Time	Merozoites in young cells	Time (21 hours later)	Mature trophozoites in old cells
1	10 P.M.	88.4 per cent.	7 P.M.	100 per cent.
2	"	75.3 " "	"	100 " "
3	"	84.6 " "	"	100 " "

The rate of maturation of these young red cells may have been accelerated or retarded because of the presence of the malaria parasites, hence the following *in vitro* experiments were carried out. Blood was drawn from canaries and kept at room temperature. Counts of young and old red cells were made at the time the blood was drawn and again at the end of 24 hours. The percentages of young cells present are given in Table 2.

TABLE 2

Bird	Young red cells in fresh blood	Young red cells after 24 hours
1	6 per cent.	0.4 per cent.
2	12.3 " "	0.2 " "
3	33.4 " "	0.2 " "

Birds 2 and 3 had been treated with phenylhydrazine in order to bring about an increase in the number of young red cells.

These *in vitro* experiments indicate that in drawn blood at room temperature practically all the young cells became mature within 24 hours. Thus the period required for the maturation of the young red cells in the peripheral blood of canaries appears to be less than 24 hours both in parasitized and in non-parasitized cells.

ROBERT HEGNER
REDGINAL HEWITT
THE JOHNS HOPKINS UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

EMBRYONIC SERIES IN SNAKES

DATA on Ophidian embryology are incomplete largely because of the difficulties involved in acquiring a satisfactory series of stages. Sacrifice of a gravid female yields an abundance of material of one stage, but to obtain a continuous record of development by this method would be almost impossible for rare or secretive snakes and both laborious and wasteful for common snakes.

To obviate this waste, Professor Peter Okkelberg, of the department of zoology of the University of Michigan, suggested that successive stages in development might presumably be obtained by a series of "Caesarean" operations on a single female. Such operations were begun in the summer of 1935 and proved highly successful.

Nembutal (sodium pentabarbital) is employed as the anesthetic. The strength most generally applicable is 0.5 per cent. in physiological saline solution. About two to three cc of this solution are injected intraperitoneally approximately at the middle of the body. Exact dosage is not important. Small snakes, such as *Diadophis* and *Tropidoclonion*, require proportionately less of the anesthetic (0.1 cc per 10 grams of

body weight) than larger snakes, such as *Natrix cyclopion floridana* Goff (1.0 cc per 30 grams of body weight). The former are fully anesthetized in from five to ten minutes and recover in six to twelve hours; the latter require one to two hours for complete anesthesia and recover in twenty-four to forty-eight hours. In approximately one hundred operations on snakes of a variety of Colubrid genera, both oviparous and ovoviviparous, no fatality has resulted from the anesthetic.

This rather striking and successful use of nembutal with cold-blooded vertebrates deserves special note. Although this anesthetic has been extensively used during the past several years both on humans and lower mammals, there is, to my knowledge, no record of its application to vertebrates below the mammals. The ill effects which sometimes accompany the use of respiratory anesthetics, such as ether and chloroform, were not apparent in snakes treated with nembutal. This observation should be of interest to workers in fields other than embryology.

The operation consists of the exposure of the oviduct by a short longitudinal abdominal slit slightly lateral to the mid-line and near the position of the most cranial embryo. The oviduct is then opened, and one or more embryos removed, the rest being left to continue development. It is not necessary to suture the oviduct and peritoneum, but the abdominal incision is closed by appressing the fleshy surfaces and securing them by a stitch of white linen thread at the base of each scute. On some ovoviviparous forms the process was repeated at intervals of three days; however, there is no reason to believe that a shorter interval would not be feasible. At each new operation, slits were made in progression posteriorly until all the embryos had been removed. I have had no opportunity to observe the effect of repeated operation on oviparous forms.

Removal of some embryos interferes in no way with the development of those remaining. Only one snake, *Thamnophis sirtalis sirtalis* (L.), was allowed to give birth to young after operation; from this specimen fourteen embryos had been removed in five weekly operations. The remaining two young were delivered at the expected time and were normal in every respect. During the summer of 1936 it was further observed that the rate of development was precisely the same in both operated and unoperated snakes which had been kept under the same laboratory conditions.

By this method it has been possible to secure embryonic material in series; it seems that this could have been accomplished in no other practical way.

HUGH CLARK

DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF MICHIGAN

PHOTOGRAPHY IN THE BIOLOGY CLASSROOM

NOTE-TAKING by means of the newer types of small cameras is a classroom technique being employed successfully by several students in my biology classes. Photomicrographs of the various slides being used in laboratory can easily be taken by using a photomicrographic collar attachment set at infinity, with an exposure of from 3 to 10 seconds on Super-Pan film. The microscope may be focused in the usual way, using light from an ordinary table microscope lamp. These photographs, when mounted and supplemented with descriptive sketches and labels, make a most attractive and useful notebook record of laboratory work. One student, using an f.2 shutter and 1 second exposure on Super-X film, has regularly been photographing lantern slides as they are thrown on the screen during lectures and then using them to advantage as addenda to his written lecture notes. Several men on our teaching staff have also found that photographs of laboratory dissections and photomicrographs of slides and tissue preparations when properly enlarged, labeled and covered with Cellophane, may be successfully used as demonstrations for short practical laboratory quizzes on occasions when circumstances do not permit the preparation of actual specimens for large numbers of students.

P. L. BAILEY, JR.

COLLEGE OF THE CITY OF NEW YORK

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SCIENCE[1]

By Dr. F. R. MOULTON

PERMANENT SECRETARY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A FEW weeks ago I read an interesting article on the enormous increase in the population of the world during the past two or three centuries. In that very brief interval the number of living human beings increased perhaps fivefold. Simply as a biological phenomenon this extraordinary growth in population in the course of fewer than a dozen generations raises interesting questions respecting causes and equally interesting ones respecting consequences.

Of the continents, Europe is by far the most densely populated, with an average of about 130 inhabitants per square mile. Then follows Asia, in which the herdes of India and China give an average of about 60 per square mile. Even in India there are only 177 persons per square mile, or about one third the population density of Great Britain, while China is less densely populated than Illinois. The average population density of North America is about 19 per square mile; in both Africa and South America it is approximately 11 inhabitants per square mile, while in Australia it is only 2.2 persons per square mile.

Several factors have undoubtedly contributed to the recent remarkable increase in world population, but it is probable that the most important of them has been the application of science. This conjecture is supported by the fact that, except in those cases in which migrations have been major factors, populations have shown the greatest increases where the applications of science have been most abundant. It is also supported by the fact that on the whole the densest populations are where science finds its highest development.

In recalling the amazing increase in human population of the globe in the past few generations and in suggesting that the increase is probably due in large

[1] Abbreviated from an address delivered before the Lancaster, Pa., Branch of the American Association for the Advancement of Science.

measure to applications of science, I am not expressing an opinion as to whether the phenomenon has been desirable or undesirable. I have no settled conviction that setting aside "the law of the survival of the fittest" by preserving and protecting the unfit will in the long run prove advantageous to the race. I have no theory that the luxuries, which are enjoyed by those who through science command the materials and forces of nature, are for their good. I simply point out that something startlingly new and extremely important is happening in the world.

It is easy to give striking illustrations of applications of science which have transformed the world. For example, the coal that is burned in the United States each day does more mechanical work than all men in the country do in a year. A ton of freight is carried a mile on the railways at a total cost to the shipper which would buy the time of an unskilled laborer for only a minute or two. A motor car, its materials gathered from all over the world and transformed into precision parts, costs less per pound than to send letters from one town to another. A 60-watt electric light is operated for almost an hour at a cost to the user of the federal tax on just one cigarette. By means in everyday use, a whisper in London can be heard in Chicago. But illustrations of the efficiency of the applications of science always fall far short of making us really understand the miracles that are being performed. One reason is that for countless generations the minds and imaginations of our race have practiced on things within the reach of our unaided hands and eyes. It can not be expected, therefore, that in a generation or two we should have acquired the power to comprehend what science is doing.

Since up to the present science has been concerned largely with material things, both inanimate and animate, we are likely to attempt to measure its importance in terms of physical phenomena. I have spoken of the efficiency of our machines. If I had chosen illustrations from the biological fields, I would have referred to the remarkable results that have been obtained from the breeding of plants and animals and in the curing of disease. Yet in the long run by far the most important consequences of science will be its effects upon our minds. For the moment I am not referring simply to such increases in knowledge as have taken place since our ancient ancestors began their ascent from the level of primitive cave men. I refer rather to revolutions in points of view and habits of mind, such as many times in the history of the world have resulted from causes which were much less important than recent science and its applications. Let me refer to one of them which is distant enough to be seen in fair perspective. When Columbus crossed the Atlantic and Magellan sailed around the earth, the accepted foundations of the physical universe were shaken; when Copernicus and Galileo advanced compelling reasons for believing that the earth is relatively a particle of matter flying in a vast orbit about the sun, those foundations were destroyed. That the revolution in point of view was profound is proven by the fact that it led to bitter controversies for nearly three centuries.

When we consider the bitterness and the length of the controversy over the question of the motions of the earth, we are quite likely to think that it was the most important intellectual revolution that ever has taken place or ever will take place. Such a conclusion is quite unfounded, I think. Certainly the ideas of Copernicus and Galileo had little, if any, direct effects upon the work and the ways of living of the world. They raised no physical burdens from the backs of men. They did not banish the specter of hunger and disease that had always lurked in the shadows of the night. They contained no new reason why a person should love his neighbor as himself. They promised no new paradise for the pure in heart. They simply tumbled man from the proud position he had assumed for himself at the summit of creation.

On the other hand, the doctrine of organic evolution is as important from the practical point of view as it is far-reaching in its philosophical implications. Though it places man in the general stream of life, it provides sound principles for developing the lower forms for his good. Though it chastens him with the story of his humble origin, it points equally to the inspiring heights to which there is a possibility of his ascending. If it were as easy to explore all the vast domain of organic evolution as it is to understand the heliocentric theory of the solar system, the work of Darwin and his successors would already have completely revolutionized our ways of thinking. But the theory of organic evolution involves all the infinite variety of the life of the present, and ties it in with that of the long geologic past. Instead of being not much more than a rather simple geometric diagram, it is a fabric woven from all the strands of life into marvelous patterns which are as yet little understood.

Up to the present I have spoken of science as though it consists of theories which gradually win their way in the minds of men. That tacit assumption may be correct so far as scientists are concerned, but the great mass of human beings are moved by simpler considerations. They respond primarily to physical things—to shelter and food and the comforts of life. Yet the fact that these comforts may be abundantly enjoyed only as a consequence of ten thousand applications of science will gradually transform the point of view of mankind. Perhaps the transformation will not be fully on the level of the conscious mind, but will consist of a

general mass psychology of which there have been many strange examples. If this condition of which I speak shall ever be attained, it will undoubtedly be over a long and winding trail, for the factors at work are many and increasing in number. The goal is, of course, an intellectual and moral world in tune with the uniformities which we know as "the laws of nature." That goal transcends in importance every other objective of science, and scientists will, I hope and believe, give it more and more attention.

In speaking of the ultimate goal of science, I do not, of course, think that scientists should attempt to hitch their wagon only to a very distant and perhaps unattainable star. There are many intermediate objectives worthy of their attention. For example, I think that scientists should very often consider science in the broader aspects of its effects upon human beings. It has sometimes been suggested that scientists should undertake to settle the problems of economics and sociology and government by the methods which they have found effective in the natural sciences. But it is probable that in those strange and wholly different fields workers in the natural sciences would be about as incompetent as politicians would be in a chemical laboratory. It would be unsafe to assume that they are masters of methods that are fundamentally different from those which other intellectually honest men attempt to use in much more difficult fields. It would be even more unsafe to assume that, as compared with men in business and other professions, they are exceptionally altruistic. The only assured fact is that they are introducing revolutionary factors in the world and, therefore, that they should feel a heavy responsibility for examining the results of what they are doing. With deep humility they should cooperate with men in other fields to discover how society may best use the titanic forces which they are placing at its command. They should do this thoughtfully and persistently lest that which so far has on the whole been good should eventually turn out on the whole to be bad.

In certain respects the steep trail science has been traveling in recent decades must soon change to a gentler slope. For example, the number of scientists in the United States has been increasing at a much higher rate than its total population. If the present geometric rate of increase of the names included in "American Men of Science" should continue even for only 150 years, this biographical book would contain sketches of the lives of more scientists than there will probably be persons in the United States at that time. In a comparable period the publication of papers on biology or chemistry would use up the printing capacity of the land. At that time a biologist or a chemist would have to spend several months each year even to glance over an abstract of *Biological* or *Chemical Abstracts*. The biologists and the chemists would have to be in continual convention in a hundred centers in order to present brief digests of their investigations. To operate their electrical equipment physicists would use more energy than all of industry and transportation. Evidently these things would not happen. Science is now in the rapidly growing springtime of its existence. Its roots are in fertile soil and its branches are rapidly pushing out in all directions. Instead of attempting the impossible task of stopping its growth for a period, as England's "gloomy dean" has proposed, it will be better to direct its development so that its fruit shall be good. This is why I am urging that scientists consider carefully the effects of what they are doing.

It is probable that scientists do not generally realize that in an exceptional way they stand upon the shoulders of their predecessors and that for this reason their progress is exceptionally rapid. A scientific principle once established becomes the property of all science; a piece of apparatus once constructed becomes a pattern for later apparatus of the same kind. But not to the same degree is a work of art or a moral principle or even a social order a stepping stone for its successor. For example, there has been more improvement in electric lights in a decade than there has been in literature since the time of Shakespeare. There has been a greater advance in our knowledge of the body of man in this generation than there has been of the moral law since the Sermon on the Mount. Beyond the domain of the natural sciences the complexities are enormous. Never are conditions in the humanities even approximately duplicated. Consequently, there do not exist in those fields the simple laws of the natural sciences. Into this complex, little-understood world, in which the minds and emotions of men are paramount factors, the natural sciences are pouring their amazing products. Although each physical product be simple itself, it may multiply enormously the complexity of the already complex social machine. For example, the automobile has created more interdependencies among our people than existed altogether thirty years ago.

There has often been an aloofness on the part of those who work in the natural sciences from the remainder of the world. Sometimes we have heard boasts that the results of an investigation never could be put to a practical use. Although the richest rewards of scientific research are esthetic, the pure joy of discovery, yet that fact does not justify any touch of snobbery on the part of scientists, for other men may get similar pure enjoyment out of the things they do. No one is qualified to say that what he does is in any way more important, except to himself, than what another one may be doing. There is no good reason for think-

ing that the fields of honest endeavor, however much they may differ otherwise, are on essentially different levels.

In view of the complexities and importance of the humanities, they have been given too little attention. When I make this statement, I am not expressing any approval of immature theories respecting the desirability of more numerous social controls. On the contrary, I think that enforced restraints into standardized patterns will destroy our capacity for improvement. I am thinking, rather, of investigations in psychology, economics, political science, social science and related fields from the objective point of view adopted by biologists, for example. I am thinking, too, of industry as not only depending on many sciences, but as being in a real sense science itself. Science pursued in this broad sense will enrich itself and the world. By its example and its influence it will gradually lead us toward the ideal condition in which every man will be worthy of having his name in "American Men of Science."

Here in Lancaster you have formed a Branch of the American Association for the Advancement of Science. In taking this step you have recognized the great importance of science and have committed yourselves to promoting its interests. I am sure that your meetings are not only profitable to your members but are advantageous to your city. I would that there were a hundred similar branches of the association to carry with high purpose and steady hands the enlightening torch of science. If the whole country were similarly organized the American Association for the Advancement of Science would have more than a million members. Then this great democratic organization would be more nearly fulfilling the dreams of those who founded it and of those who have untiringly devoted their energies to its interests.

Although your meetings here in your own branch are pleasant and profitable, I trust you will not neglect the general meetings of the association. In them you will find rich programs of papers by specialists in nearly every field of natural and social science. You will have the inspiration of contacts with the scientific leaders of the country; and I hope that the association will continually increase the opportunities it offers for meeting and hearing addresses by the eminent scientists of the world. These leaders in the fields of science are the real authors of history. Their work is having more fundamental effects than all the laws which have ever been enacted or all the armies that have ever marched in triumph. The benefits that flow from their achievements are not limited by race or creed or political boundaries or even by time. They offer a perfect example of the fact that "it is more blessed to give than to receive." They provide physical comforts for all men and gradually free their bodies from disease and their minds from the terrors of superstitions. They give to their fellow scientists enchanting new views into the regions which they explore. They prepare for posterity a new world in which to live. I hope the American Association for the Advancement of Science will make a more prominent feature of its programs the appearance of heroes of science. I do not express this hope for the sake of the eminent scientists themselves, but for the benefit of those who serve more humbly in the ranks of science, and particularly for those who look at it from afar through the columns of the daily press. Since men are hero worshippers, it is sound policy to exalt those who are the world's real heroes in a fundamental sense. If this is done honestly and effectively, all of us will realize more fully the importance of what science is doing, and we shall more thoughtfully consider its consequences.

In an earlier geological age certain animals grew so large that their unwieldiness led to their extinction. In our day several fields of science have grown so greatly in numbers of workers and in volume of output that they are becoming seriously unwieldy. Although they are not growing toward a condition that will result in their destruction, the difficulties of arranging for their meetings steadily become more and more serious, and the problem of publishing the results of their investigations more and more nearly impossible of satisfactory solution. Naturally, the American Association for the Advancement of Science, which includes nearly all the natural and social sciences, is confronted with similar difficulties. Indeed, if it undertook to do for all the sciences just what the society for each science does for its own members in the way of providing opportunities for the presentation and publication of highly specialized papers, it would be in danger of bogging down into confusion and ineffectiveness. Instead of narrowly traveling this road, it is giving more and more attention to syntheses of science. In particular fields it encourages symposia by competent authorities. The ideal symposium presents the fundamentals of a domain of science in historical and essential perspective. It is quite possible that the American Association for the Advancement of Science will become the most important agency in the country for promoting and publishing symposia. Its organization gives it the broadest opportunities for such undertakings, and it has unequalled advantages for arranging symposia that reach across the boundary lines of related but usually separated fields. It has an opportunity of being a pioneer in the difficult and undoubtedly extremely important problem of bringing the natural, social and industrial sciences into

mutual understanding and close cooperation for the future of civilization. If the association shall profit by the extraordinary examples of efficiency presented by industry, it will organize its varied and enormous resources in membership to make science in a broad sense the brightest light in the world.

In this local gathering there is something of hominess and comfort which we all enjoy. Here is expressed to an exceptional degree this kindly, unselfish spirit of science. But the meetings of the association as a whole are more like an army on the march. They involve masses and administrative machinery and simultaneous movements on a hundred fronts. Yet they can be so organized that each individual who attends them not only will commune with his fellow specialists, but, through addresses by the heroes of science and by symposia, will be raised to heights from which he can survey the field of operations of the great army of which he is a part. Then, in slightly paraphrased words of Byron, he will say at the close of each meeting of the association:

> I love not Nature less, but Man the more,
> From these our interviews, in which I steal
> From all I may be, or have been before,
> To mingle with the Universe, and feel
> What I can ne'er express, yet can not all conceal.

SCIENTIFIC EVENTS

THE OXFORD UNIVERSITY BUREAU OF ANIMAL POPULATION

THE first annual report of the Oxford University Bureau of Animal Population is summarized by a correspondent of the London *Times*. He states that the inception of the bureau is due to its present director, Charles Elton, whose researches on the regular fluctuations in numbers shown by many wild animals convinced him of the high theoretical and practical importance of the problem of animal population. The bureau was first established in 1932 with the aid of a grant from the New York Zoological Society and with the general approval of the University of Oxford. A trial period convinced the university authorities of the value of the work, and the bureau is now an official institution, with a grant from the university towards its expenses and a fellowship at Corpus for its director. The correspondent writes:

> The range of contacts established by the bureau is remarkable for what is still a small institution. Their main piece of research, on the fluctuations in numbers of voles, is supported by the Royal Society, the Forestry Commission, the Medical Research Council and the Agricultural Research Council, and there has been cooperation with such different bodies as the Scottish Meteorological Office and the London Zoo. The research on partridge numbers is chiefly financed by Imperial Chemical Industries, with aid from private estate owners throughout the country. A remarkable example of cooperative research is that on the fluctuation of the snowshoe rabbit in the North American continent. For this reports are analyzed from nearly 700 separate observers, from the Hudson's Bay Company, the Canadian National Parks Service, a paper corporation in Anticosti, the Alaska Game Commission, the Newfoundland Department of Natural Resources and the United States Bureau of Biological Survey.
>
> Results of this and related inquiries have made it possible to build up a picture of fluctuations in Canadian wildlife for over 100 years. The period of the fluctuation was originally supposed to be determined by the 11-year sun-spot cycle, but the more accurate records now available show that this can not be. The period averages a little less than 10 years, and must be determined by some hitherto undiscovered climatic cycle. That this is likely to be so is shown by the research on vole plagues. The numbers of voles, it was found, fluctuate with a three- to four-year periodicity. Quite recently the superintendent of the Scottish Meteorological Office has discovered a rhythm in factors affecting storminess, which exhibits an identical rhythm that unquestionably (though by what precise means is still unknown) causes the voles' fluctuations. Thus for certain purposes animal numbers may constitute a new type of meteorological instrument, serving to detect hitherto unsuspected weather-cycles.

A side-line undertaken by the bureau is the investigation of the fluctuation in numbers of the semi-wild exotic animals which have been liberated in Whipsnade. The researches of the bureau have great practical importance. If adequate records are available scarcity due to persistent over-destruction can be readily distinguished from the purely temporary scarcity due to a "crash" in a normal cycle of fluctuation. Among the fur-bearing carnivores of Canada, for instance, the lynx and fox show normal cycles; but the marten has been over-trapped and now is no longer able to increase rapidly in numbers at regular intervals as it used to do.

THE MARIA MOORS CABOT FOUNDATION FOR BOTANICAL RESEARCH

THE establishment of the Maria Moors Cabot Foundation for Botanical Research is announced by Harvard University. The initial endowment is $615,773, provided by Dr. Godfrey L. Cabot, of Boston, a graduate of Harvard College in the class of 1882. The income from this fund is to be used for the first fifty years for plant research, all restrictions being removed after this period. The purpose of the gift is to investigate methods of increasing the rate of growth of plants, especially trees, and consequently the rate at

which they convert sunlight into cellulose and other vegetable substances. The income will be expended through existing botanical units of Harvard University, and largely through the Harvard Forest at Petersham in cooperation with those associated with the Biological Laboratories, the Bussey Institution and the Arnold Arboretum. Dr. Cabot's gift can be used for direct research, without heavy capital investments for land, library or laboratory facilities.

President James B. Conant said in connection with the announcement of the gift:

The foundation is a first and highly important step toward the creation in Harvard University of a broad and far-reaching program of advanced research and instruction in the whole range of the conservation of natural resources. The current reorganization of the Harvard Forest and the creation of the Harvard Graduate School of Public Administration have sharply focussed the attention of the university on the urgent need and the opportunity for such a program.

A statement made by Dr. Elmer D. Merrill, administrator of botanical collections at the university, reads in part:

The extraordinary achievements in improving the vigor, hardiness and productivity of food plants and of domestic animals by scientific selection and by hybridization are common knowledge. Very little comparable work has ever been attempted in the case of forests, one of our most valuable plant associations. This in part is due to the baffling complexities involved in breeding improved strains of plants with such a long life span as trees, and in part to the fact that mankind has hitherto been able to rely largely on wild forests for timber and cellulose. It is only in the past 150 years that Europe has used intensive forest culture, and only in the past generation that America has made a beginning in that direction. As, however, only about fifteen per cent. of the forests of the world are under scientific cultivation and the rest are being threatened by destructive exploitation, the danger to the world's future supply of wood and cellulose is apparent. One important and promising solution of the problem lies in improving the strains of trees used in the cultivated forests of the world, and it is on that aspect that Harvard University is now enabled to launch a significant research program through the generous gift of Dr. Cabot.

Among those who will be actively engaged on the work at the start will be Professor E. M. East and Professor Karl Sax, who will study the hybridization of trees by artificial pollination in order to evolve more rapidly growing strains. They will attack also the problem of doubling the chromosome numbers in order to increase the size and especially the vigor and hardiness of selected species and to permit reproduction of hybrids by seed instead of by vegetative reproduction.

Professor K. V. Thimann will work on the vegetative propagation of the most promising natural strains, particularly of conifers. Vegetative propagation of trees presents the possibility of a short cut as compared with hybridization, since it permits working with immediately promising natural strains. Professor P. R. Gast, of the Harvard Forest, will continue his present experiments on the effect of controlled quantities of tree nutrients and solar radiation on the growth of trees, and will extend the work to nutritional qualities of natural forest soils and their improvement by the silvicultural treatment of the forest. Professor Gast will also have charge of the selection and propagation of the most promising natural strains of different trees, which are known, in many cases, even in the same species, to vary widely.

SEVENTH ANNUAL FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

THE seventh annual meeting of the Field Conference of Pennsylvania Geologists was held at Bradford, Pa., over the week-end of May 28, 29 and 30. The attendance of fifty-one members and guests included, besides Pennsylvanians, geologists from Connecticut, New Jersey, New York, West Virginia, Ohio and the District of Columbia. The Conference Committee consisted of Professor C. A. Bonine, *chairman*, Professor C. R. Fettke and Stanley H. Cathcart. The local committee was made up by A. C. Simmons and J. C. Martin.

On Friday afternoon an inspection trip was made through the Kendall Oil Refinery, in Bradford, and this was followed by a visit to a lease of the Petroleum Reclamation Company. On Saturday the entire conference participated in a stratigraphic trip in the Bradford district, which was led by Professor Fettke. Strata in the Pennsylvanian, Mississippian and Devonian Systems were examined. These embraced the Mercer shale and coal, and the Olean conglomerate in the Pottsville Series (Pennsylvanian), the Knapp formation in the Mississippian, and the Oswayo, Cattaraugus and Chemung beds in the Devonian.

On Sunday, May 30, the group divided into two parties. Trip A, under the leadership of Dr. Kenneth Caster, spent the day in studying Pennsylvanian, Mississippian and Upper Devonian strata in the area covered by the Warren Quadrangle. The chief interest in the stratigraphic studies in the Bradford and Warren areas is concerned with their relationships to the Bradford and Venango Oil Fields of northwest Pennsylvania. Trip B, led by Professor Henry Leighton, journeyed to Erie, Presque Isle and vicinity to study Pleistocene and Recent shore-line features.

The annual dinner was held at the Emery Hotel in Bradford on Saturday evening. After the dinner, a presentation of local geology was given by Dr. Caster. During a brief business meeting following his talk an invitation from Dr. Arthur Bevan, state geologist of

Virginia, was accepted to hold the eighth annual meeting largely in Virginia. The Field Conference Committee consists of Dr. Arthur B. Cleaves, *chairman*, Professor Frank M. Swartz and Professor R. E. Sherrill.

ARTHUR B. CLEAVES,
Secretary-Treasurer

GRANTS OF THE GEOLOGICAL SOCIETY OF AMERICA

THE following twenty-seven grants in support of special research projects were authorized by the council of the Geological Society of America at a meeting held on April 24.

Maurice Ewing, Bethlehem. Grant of $4,700 covering construction of apparatus suitable for use in work on the deep-sea floor and provision for necessary auxiliary apparatus, and measurement of the thickness of sedimentary deposits beyond the edge of the continental shelf by means of this apparatus.

Alfred S. Romer, Cambridge. Grant of $3,500 covering assistance and incidental expenses involved in compilation of a bibliography of fossil vertebrates.

Edward B. Mathews, Baltimore. Grant of $700 covering assistance and expenses in compiling published chemical analyses of rocks.

Nelson H. Darton, Washington, D. C. Grant of $700 covering field and office expenses in completion of investigation of the overlap relations of Tertiary and Cretaceous formations in eastern Maryland and Virginia.

Bruce L. Clark, Berkeley. Grant of $500 for assistance in completing monograph on radiolarians from the Cretaceous and Eocene of Middle California.

J. T. Rouse, Columbus. Grant of $450 for field and other expenses connected with study of the volcanic rocks and related problems in the Shoshone Mountains, Wyoming.

David M. Delo, Appleton. Grant of $35 for completion of illustrations for a monograph on the North American phacopid trilobites.

Mrs. Helen Tucker Rowland, Ithaca. Grant of $300 covering traveling and office expenses connected with completion of monograph on the Caloosahatchie fauna of Florida.

A. C. Veatch, New York. Grant of $3,000 covering preparation and printing of charts in study of submarine valleys off the Atlantic Coast, beyond the 1,000-fathom line.

Marcellus H. Stow, Lexington, Va. Grant of $665 covering field and office expenses of study of sedimentation and stratigraphy of the northwestern part of the Big Horn Basin and the southern part of the Crazy Mountain syncline, Montana.

Mrs. Margaret F. Boos, Denver. Grant of $350 for field and office expenses of detailed study of granite plutons of the Indian Creek area, Denver Mountain Park.

David T. Griggs, Cambridge. Grant of $900 covering cost of building and installing a hydraulic press needed in further studies of the mechanics of rock deformation under conditions of high pressure and high temperature.

Howard A. Coombs, Seattle. Grant of $400 for field and office expenses of a comparative study of Mts. Rainier and Baker.

Vincent P. Gianella, Reno. Grant of $200 for field and office expenses of investigation of piedmontite mineralization in metamorphosed volcanic rocks near Reno, Nevada.

Ralph W. Imlay, Ann Arbor. Grant of $1,125 covering field and museum study and preparation of manuscript on Upper Jurassic marine faunas of northern Mexico and of certain critical areas for correlation of Jurassic and Lower Cretaceous stratigraphic sections.

Harry N. Eaton, Syracuse. Grant of $100 covering field expenses of study of glacial advances in Allegheny County, New York.

J. Harlan Johnson, Golden, Colo. Grant of $200 for laboratory and office expenses of study of algal limestones of the Upper Paleozoic section in the Rocky Mountain region.

Stuart A. Northrop, Albuquerque, N. Mex. Grant of $300 for traveling, living and office expenses of study of the paleontology and stratigraphy of the Silurian Chaleur series of the Port Daniel-Black Cape region, Gaspe.

George M. Stanley, Ann Arbor. Grant of $315 covering field and office expenses of study of lower Algonquin beaches in the Upper Great Lakes.

Perry Byerly, Berkeley. Grant of $900 for assistance in study of northern California earthquakes, as recorded at the group of stations of the University of California.

Paul D. Krynine, New Haven. Grant of $240 for traveling, field and laboratory expenses of sedimentary study of the Pleistocene deposits of the Bristol Gorge, Connecticut.

A. K. Miller and W. M. Furnish, Iowa City. Grant of $500 covering assistance and office expenses of detailed study of Permian ammonoids of the Guadalupe Mountains and adjacent areas.

Everett C. Olson, Chicago. Grant of $750 covering one half of the traveling and field expenses of an expedition to the Tambla locality, Province of Gracias, Honduras, to collect vertebrate fossils.

Arthur Keith, Washington, D. C. Grant of $500 for field expenses connected with studies of the Appalachian folded belt in the Province of Quebec.

Biological Abstracts, Philadelphia. Grant of $1,500 covering assistance in paleontological service.

T. T. Quirke, Urbana. Grant of $983.50 covering assistance and laboratory expenses of studies directed to the measurement of the index of refraction of opaque or nearly opaque substances by reflection.

W. F. Prouty, Chapel Hill. Grant of $1,000 covering field and other expenses connected with study of the origin of the bays in the Atlantic Coastal Plain area.

RECENT DEATHS AND MEMORIALS

DR. PHILIP B. WOODWORTH, consulting engineer, formerly dean of the School of Engineering of Lewis Institute, Chicago, and president of the Rose Poly-

technic Institute, died on June 7 at the age of seventy-one years.

DR. HIRAM COLVER MCNEIL died on June 8 at the age of seventy years. He was lecturer in chemistry at the George Washington University from 1910 to 1918 and head of the department from 1918 to 1933, when he retired. Dr. McNeil had previously been at various times a member of the U. S. Geological Survey, the Bureau of Chemistry and the National Bureau of Standards.

THE death on June 8 is announced at the age of eighty years of Victor Lieberman, at one time an associate of Louis Pasteur.

EMERITUS PROFESSOR ARTHUR GEORGE PERKIN, of the University of Leeds, distinguished for his work in color chemistry, died on May 30 at the age of seventy-five years. He was the second son of the late Sir William Henry Perkin, founder of the coal tar color industry.

Nature reports the death of J. H. Field, formerly director of observatories in India, on May 19, aged sixty-four years, and of Professor Albert Griffiths, formerly professor of physics in Birkbeck College, University of London, on May 24.

A BRONZE plaque in memory of the late Roger Griswold Perkins has been erected by his friends in the reading room of the department of hygiene and bacteriology of Western Reserve University. Dr. Perkins was professor of preventive medicine from 1910 to 1930 and professor emeritus from 1930 to 1936.

SCIENTIFIC NOTES AND NEWS

DR. EDWARD LAURENS MARK, Hersey professor of anatomy, emeritus, at Harvard University, director of the Zoological Laboratory from 1900 to 1921 and director of the Bermuda Biological Station for Research from 1903 to 1931, attained his ninetieth birthday on May 30. His friends and former students celebrated the occasion by writing letters expressing personal congratulation and appreciation of his important services to biological science. The letters, numbering about a hundred, were collected and substantially bound into a volume, which was informally presented to him on his birthday.

THE retirement in June of Dr. William Webber Ford as professor of bacteriology in the School of Hygiene and Public Health of the Johns Hopkins University is being made the occasion for the presentation of a token of regard from his former students and associates. A number of rare or unusual books in bacteriology and mycology have been chosen for the gift. Among these are early editions of the complete works of Fracastoro, Redi and Spallanzoni and the recently published Icones Farlowianae from Harvard.

DR. PHILIPP LENARD, professor of physics at the University of Heidelberg, celebrated his seventy-fifth birthday on June 7.

DR. G. F. HERBERT SMITH retired from the British Museum (Natural History) on May 26. He joined the staff of the museum in 1897, when he was attached to the mineral department. From 1921 to 1935 he acted as secretary of the museum, returning in the latter year to his original department as keeper.

DR. L. O. HOWARD has been elected an honorary member of the German Entomological Association, Berlin.

AMONG honorary degrees conferred at the hundred and fifth commencement of New York University was the doctorate of science on Dr. Charles Franklin Kettering, president of the General Motors Research Corporation, and the doctorate of public health on Dr. James Alexander Miller, president of the New York Academy of Medicine.

WILLIS R. GREGG, chief of the U. S. Weather Bureau, received on June 7 the honorary degree of doctor of science from Norwich University. Colonel Porter H. Adams, president of the university, made the citation: "To Willis Ray Gregg, meteorologist and executive; chief of the United States Weather Bureau; pioneer in the study of the meteorological problems of aeronautics, who justly is acclaimed as a distinguished contributor to the advancement of the science of meteorology."

PROFESSOR H. H. NININGER, director of the Nininger Laboratory, curator of meteorites in the Colorado Museum of Natural History, Denver, and secretary-treasurer of the Society for Research on Meteorites, has been awarded the honorary degree of doctor of science at the fiftieth annual commencement exercises of McPherson College, Kansas.

MISS WINIFRED GOLDRING, assistant state paleontologist, New York State Museum, Albany, has received the honorary degree of doctor of science from Russell Sage College, Troy, N. Y.

DR. E. V. ALLEN, of the Mayo Clinic at Rochester, Minn., has been elected president of the section for study of peripheral vascular disease of the American Heart Association; Dr. Irving Wright, of the Post-Graduate Hospital, New York, has been elected vice-president, and Dr. Irvine H. Page, of the Hospital of the Rockefeller Institute, New York City, was reelected secretary-treasurer.

THE officers, executive committee and members of the Division of Geology and Geography, National Research Council, for the year beginning on July 1, are as follows: *Chairman*, Chester R. Longwell; *Vice-chairman*, Robert S. Platt; *Executive Committee*, Chester R. Longwell, Robert S. Platt, Edson S. Bastin, John L. Rich, J. F. Schairer and John K. Wright; *Representatives of Societies*, A. F. Buddington and John L. Rich, Geological Society of America; J. F. Schairer, Mineralogical Society of America; Charles Butts, Paleontological Society; Preston E. James and Robert S. Platt, Association of American Geographers; John K. Wright, American Geographical Society; Edson S. Bastin, Society of Economic Geologists; Robert B. Sosman, American Ceramic Society; F. H. Lahee, American Association of Petroleum Geologists; *Members at Large*, Florence Bascom, Chester R. Longwell and L. F. Thomas.

THE annual meeting of the Royal Society of Canada was held at the University of Toronto from May 25 to 28, under the presidency of Lawrence J. Burpee, of Ottawa, who took as the subject of his presidential address "The Discovery of Canada." During the meeting the Flavelle Medal for scientific research was presented to Dr. Frank D. Adams, the Lorne Pierce Medal for literature to Dr. Stephen Leacock and the Tyrrell Medal for historical research to Aegidius Fauteux. In the three sections devoted to science and their various sub-sections, two hundred and twenty papers were presented. Dr. A. G. Huntsman, consulting director of the Biological Board of Canada, editor of its publications and professor of marine biology at the University of Toronto, was elected president of the society for the year 1937–38.

AT Kansas State College, Dr. A. B. Cardwell has been appointed head of the department of physics, succeeding Professor J. O. Hamilton, and Dr. W. T. Stratton has been appointed head of the department of mathematics, succeeding Professor B. L. Remick. Professors Hamilton and Remick have served on the college faculty since 1900 and will continue teaching for part time.

DR. RICHARD WEISSENBERG, for many years a member of the medical faculty of the University of Berlin, has been appointed visiting professor of cytology at the School of Medicine of Washington University, St. Louis.

DR. WOLDEMAR WEYL has been appointed professor of glass technology at the Pennsylvania State College, effective next January. For the past six years Dr. Weyl has been in charge of investigations on glass at the Kaiser Wilhelm Institut. During the academic year 1936–37 he has been visiting professor at the Pennsylvania State College and has given lectures at the Ohio State University, Princeton University and the University of Illinois. He is at present in Germany.

DR. ROBERT WALLACE VIRTUE, instructor of biochemistry in the Louisiana State University, has been appointed assistant professor of biochemistry at the University of Denver.

DR. R. M. CALDWELL, of the U. S. Bureau of Plant Industry, has been appointed chief of the department of botany, and R. W. Samson has been appointed assistant chief at the Agricultural Experiment Station of Purdue University.

DR. LEON PRATT ALFORD has been appointed professor of administrative engineering and chairman of the department of industrial engineering at New York University to succeed Professor Joseph Wickham Roe, who is retiring as professor emeritus after sixteen years of teaching and administrative service.

DR. HENRY ROY DEAN, master of Trinity Hall and professor of pathology in the University of Cambridge, has been elected to the office of vice-chancellor for the year 1937–38.

T. G. ROSE has been appointed general director of the British National Institute of Industrial Psychology, to collaborate with Dr. C. S. Myers, the principal, who will retain the position held by him since the inception of the institute sixteen years ago.

GRANTS of the Committee on Scientific Research of the American Medical Association have been made to Dr. Fred L. Humoller, assistant professor of physiological chemistry at the Loyola University School of Medicine, for a study on the chemistry of the toxic principle found in culture fluids of *B. enteritidis*; to Dr. Elizabeth Shull Russell, of the Roscoe B. Jackson Memorial Laboratory of Bar Harbor, Me., for a study of the genetics of tumors in the fruit fly, *Drosophila melanogaster*; to Dr. Orthello R. Langworthy, of the Johns Hopkins University, for the study of the effect of ovulation and pregnancy upon the smooth muscle of the urinary bladder; and to Professor Roe E. Remington, professor of nutrition in the Medical College of the State of South Carolina, for the continuation of his work on the metabolism of iodine in the rat.

DR. MAURICE HOLLAND, who is at the head of a delegation that is visiting laboratories in England, Germany and France under the auspices of the Division of Engineering and Industrial Research of the National Research Council, spoke at a luncheon given by the American Chamber of Commerce in London on May 25.

EDGAR BROWN, of the U. S. Department of Agriculture, and Mancel T. Munn, of the State Agricultural

Experiment Station, Geneva, N. Y., have been appointed official delegates of the U. S. Government to the eighth International Seed-Testing Congress at Zurich. The congress will hold its sessions from June 29 to July 4.

DR. Z. KOZMINSKI, of the Wigry Biological Station at Suwalki, Poland, is carrying on research work in limnology at the University of Wisconsin during the month of June. During July and August he will be in residence at the Trout Lake Limnological Laboratory, where he will study the photosynthesis of the phytoplankton and the copepod fauna of the lakes of that district.

DR. HAROLD ST. JOHN, botanist at the Bishop Museum, Honolulu, will sail on June 28 for Fiji to continue the exploration sponsored by the museum of the South Sea Islands. He expects to collect plants for two months, principally on the interior plateau of Viti Levu, which is relatively unknown botanically.

Professor J. G. FITZGERALD, director of the School of Hygiene at the University of Toronto, has a year's leave of absence to study the teaching of preventive medicine in medical schools in the United States, Canada, the British Isles and other countries of Europe for the Rockefeller Foundation. Professor FitzGerald gave a Chadwick Public Lecture in London on May 26. His subject was "Preventive Medicine—an Avenue of Good Will."

DR. C. H. ROBERTSON recently completed a lecture tour of eight chapters of Sigma Pi Sigma, physics honor society, at Miami University, the University of Kentucky, Berea College, the University of Chattanooga, the College of William and Mary, the University of Richmond, West Virginia University and the Ohio State University. The subject of the series was "Gyroscopes and Boomerangs."

SIR ARTHUR EDDINGTON, director of the observatory and Plumian professor of astronomy at the University of Cambridge, gave the eighth annual Haldane Memorial Lecture at Birkbeck College, London, on May 26. His lecture was entitled "The Reign of Relativity, 1915–1937."

THE seventh annual research conference of the department of chemistry of the Johns Hopkins University is being held from June 7 to June 25, at the Cavalier Hotel, Virginia Beach. The subjects are "Enzymes" during the first week, "Phenanthrene Chemistry" during the second week and "The Mechanism of Some Homogeneous Organic Reactions," including oxidation, chlorination and polymerization, during the third week. These conferences provide an opportunity for discussion among a group of specialists in a particular field of chemistry. The meetings are kept as informal as possible, there are no printed papers, and no formal record of the proceedings is kept. It is preferred that attendance be limited to those working in the field under discussion or in closely allied fields, so that the groups may be small enough for each person to take part in the discussion. The conference is under the direction of Professor F. O. Rice, department of chemistry, the Johns Hopkins University, Baltimore, Md.

SIGMA PI SIGMA, physics honor society, installed its thirty-first chapter on May 10 at John B. Stetson University, DeLand, Florida. Dr. Marsh W. White, the Pennsylvania State College, was the installing officer and spoke at the first open meeting of the chapter, following the installation, on "Modern Alchemy."

THE installation of the Illinois Alpha Chapter of the Alpha Epsilon Delta Honorary Premedical Fraternity at Illinois Wesleyan University, Bloomington, was held on May 21. Dr. Emmett B. Carmichael, professor of physiological chemistry at the School of Medicine of the University of Alabama and grand president of the fraternity, conducted the ceremonies, which marked the installation of the eighteenth chapter since the establishment of the fraternity at the University of Alabama in 1926.

DISCUSSION

THE EXCESSIVE MEEKNESS OF AMERICAN BOTANISTS

THE meekness of American botanists has been so long and so generally recognized that no comment was offered and certainly no surprise was occasioned when some years ago Seifriz[1] quoted a visiting Swiss botanist as calling attention to the fact that it is easy in most American universities to recognize the botany building, because it is the "oldest building to be seen anywhere." We have, however, taken a certain satisfaction in the feeling that our zoological friends were ready to assert themselves, to think and to act independently, and that thus a fair balance would be maintained, and the general field of biology adequately, if not evenly, cultivated.

Rather recently, however, there has appeared in various quarters the more disturbing suggestion that

[1] *The Scientific Monthly*, May, 1928.

the apparent forcefulness of zoologists is relative only to their botanical associates and that biologists as a group are inclined to be meek and to accept their basic theories and even their methods ready-made and second-hand; moreover, that these hand-me-downs do not really fit. For example, Whitehead[2] says, ". . . at the present moment, the prestige of the more perfect scientific form belongs to the physical sciences. Accordingly, biology apes the manners of physics. It is orthodox to hold that there is nothing in biology but what is physical mechanism under somewhat complex circumstances." To which Russell[3] adds, ". . . Biology, impressed by the success of physical concepts in their own sphere at the time of the great development of the classical mechanics, took over to itself concepts and methods which were clearly inappropriate and inadequate."

Now criticism of this sort is disturbing enough, but after all, we have been believing that most of the workers in any field need not concern themselves with fundamental theory—provided, of course, they are doing their daily duty of accumulating "facts" with proper zeal and appropriate methods. Even this haven of refuge seems now endangered from two distinct angles, one, that the very volume and variety of the accumulated facts make real comprehension more difficult; and the other, that our present methods are as badly suited to our needs as our present concepts. On the first point, witness Crowther,[4] "But the neglect of comprehensive synthesis by which all the facts could be ordered led to intellectual chaos, just as the blind drive to increase production of goods, without working out any comprehensive system of distribution, led to chaos in social life," or Lyon,[5] who says the same thing in medical rather than economic figures. "There is a serious side to this unabsorbed gorge of science. It has given our people a bad indigestion. It lies in the public stomach and troubles their dreams. They do not know enough to know good science from bad." And on the second, Sullivan[6] says: ". . . Discrimination is fatiguing; also it makes appeal to sensibilities which many earnest 'scientific workers' do not possess. It is much easier to make measurements than to know exactly what you are measuring. To give up the ideal of measurability would be the equivalent, to many people, of abandoning 'science' altogether. 'Science is measurement,' we are told. . . . In their eagerness to measure something, our researchers seem to lose their ordinary common sense, whereas their subject really requires the subtlety and sympathy of a very good novelist."

This last challenge is particularly disturbing to our complacency, since it at least suggests that the real foundation of our recently acquired faith in supposedly exact measurement may be found in mental laziness. For botanists—American botanists at least—have at last discovered mathematics and appear cheerfully ready to abandon any form of inquiry or information gathering which does not readily lend itself to measurement and statistical analysis. Like all good converts, we are trying to be more orthodox than the Pope, for the mathematicians are quite ready to concede that there are in biology important fields of inquiry where mathematics can play little part. To quote Carmichael[7]: "It must also be remembered that there are important Chapters of Science which do not come readily under the domain of number. Witness much of biology and in particular the theories of phylogenetic development." Some would go even further. Whitehead[8] agrees with Henri Poincaré in insisting "that instruments of precision, used unseasonably, may hinder the advance of science."

Certainly, within the writer's field of study (plant diseases) there occur phenomena which appear to defy accurate measurement by present methods, yet which seem important and abundantly worthy of record. Reference is here made to the fluctuations in plant disease which are of very great biological interest and economic importance, but which are most inadequately recorded, largely because they do not appear to be readily measurable. That large differences occur no one denies. That they are hard to measure is granted. The essential difficulty of the undertaking is emphasized whenever the accurate measurement of losses from a single plant disease is undertaken. One of the most interesting recent attempts[9] is based on a comparison of the yields of adjacent smutted and smut-free plants of dent corn. In spite of the care used in the field work and in the analysis of results, this work is still open to the criticism that the diseased plants may have become infected because they were different in the first place.

However, a discussion of the methods of measuring disease losses does not belong in this paper. There is no present possibility, even if we had developed the technique, of making measurements of losses due to even the important known diseases of our agricultural crops. Largely on this account, there is a decided, possibly an increasing, reluctance on the part of plant pathologists to record these differences at all. This willingness largely to ignore for purposes of record anything which can not be measured and set down in mathematical terms is, of course, just one more mani-

2 "Science and the Modern World," p. 144.
3 "The Interpretation of Development and Heredity," p. 168.
4 *Soviet Science.*
5 *Sigma Xi Quarterly*, December, 1936, p. 208.
6 "Gallio—or the Tyranny of Science," p. 50.
7 *The Scientific Monthly*, December, 1935, p. 495.
8 "Adventures of Ideas," p. 311.
9 I. J. Johnson and J. J. Christensen, *Phytopathology*, 25: 223–238, 1935.

festation of the excessive meekness of American botanists. There may well be biological phenomena, the *record* of whose occurrence is more important than their measurement and which should be recorded even if they can not be measured. For example, only a few years ago, 1931, eel grass (*Zostera marina*) was common in the shallow waters of the Atlantic seaboard, from North Carolina to Nova Scotia—now it is rare. Its diminution was so sudden that no opportunity was given for statistical study, even by the quadrat method. Yet obviously the biologists of the future are entitled to the information that a striking phenomenon occurred in our coastal waters at this period, even if we are not able to furnish figures.

This is, of course, an extreme case, but somewhat similar situations arise over and over again in our consideration of the variations in the incidence of plant diseases. For example, it is biologically and economically important to know that bacterial wilt was exceedingly abundant on sweet corn in the Hudson Valley of New York in 1932 and 1933 and very rare in 1934 and 1935, but whether the loss occasioned in the earlier years was 20 or 40 per cent. and whether the loss in the two later years was one half or three fourths of 1 per cent. is of merely academic interest. In 1932 and 1933 the losses were disastrous, and in 1934 and 1935 negligible.

Nothing could be further from my thoughts than to suggest any radical reform such as would be needed to alter our general professional attitude or develop new concepts and methods particularly suited to the study of living things. I certainly cherish no illusions as to the possibility of securing some slowing down of the rate of accumulation of observations or even a little breathing spell during which we might consider what, if anything, these accumulated facts signify. Quite the contrary, I propose merely that we students of living things shall not restrict ourselves to the type of observation or record prescribed by devotees of other branches of science, but shall record as clearly as we may whatever phenomena seem interesting to us, even though we can not measure them with great accuracy. For such unrestrained self-expression, Dr. Sarton has recently furnished an adequate slogan in his book, "The Study of the History of Science"—"No scientist worth his salt has ever abandoned an investigation simply because the attainable precision was too low."

NEIL E. STEVENS

UNIVERSITY OF ILLINOIS

"RACES" AND "HOMING" OF SALMON

IN support of the theory of the "homing" of salmon from distant places in the sea, Dr. Willis H. Rich[1] puts forward the argument that the local "races" of the Pacific salmon could not exist if the fish did not return to their own rivers, seeing that large numbers of them travel hundreds of miles in the sea before entering streams. It would appear, however, that the theory of "races" is in somewhat comparable condition to that of "homing" from distant places, in that adequate proof is lacking.

The characters that have been used to distinguish "races" in species of marine fishes, such as herring and cod, are being demonstrated to result from the action of the environment on the individual during its lifetime, so that it seems doubtful whether there are heritable differences between the populations of different districts. Without such differences the use of the term "race" would seem valueless. It would be interesting to know whether the "races" of any species of Pacific salmon have been shown by rigid experiment to have differences that are heritable rather than the effect of the environment.

It has been maintained for the Atlantic salmon not only that the different rivers have more or less peculiar "races," but also that the same river may contain two different "races," one entering early and the other late in the season, although not spawning at different times. This theory has been causing the Canadian Government to spend considerable money in securing the early running fish and in keeping them till spawning time for breeding purposes, since both anglers and commercial fishermen desire the early fish not only because they are available in the fishing season, but also because they tend to be larger than the late-running fish.

As crucial a test as possible[2] was made of this theory of "races" by taking the fry of Restigouche salmon, which characteristically run early and large (ordinary salmon and big salmon) and planting them in a salmonless branch of Apple River at the head of the Bay of Fundy in the middle of a district characterized by the salmon entering the streams only late in the season and almost wholly as grilse (small salmon). The transplantation was made in 1932 by Mr. H. C. White after studying the behavior of the local fish. He followed the result during the following years, marking the Restigouche smolt when they descended to the sea in 1934 and trapping the adults during the seasons of return. The experiment was concluded in 1936. He was unable to detect any difference between the Restigouche fish and the local fish in size (year of return), in season of return or in any other character except rapidity of growth in the stream, for which the conditions were not comparable. While such a result is no proof that races do not exist elsewhere, it is evidently desirable that local populations should not be considered to be racially

[1] SCIENCE, 85: 477–478.

[2] Ann. Rep. Biol. Bd. Can., 1932, 1933, 1934, 1935 and 1936: 43, 45, 10, 8–9, and 10–11, 1933, 1934, 1935, 1936 and 1937.

distinct until heritable differences have been definitely demonstrated.

A. G. HUNTSMAN

BIOLOGICAL BOARD OF CANADA
TORONTO

PHILOSOPHY OF PHYSICS

PROFESSOR HOUSTON'S recent article[1] on the philosophy of physics discusses the significance of quantum mechanics for the philosophical problem of the existence of the external world. I believe that physical theory is neutral toward this problem, and in the following I restate a theory[2] of the relation between perception and the physical world, which provides an adequate basis for science but does not commit one to a specific philosophy.

The primary factor in science is perception. Perceptions are found to be correlated. A perception which belongs to a correlated set of actual and possible perceptions is interpreted to be a perception of some physical body. A theory of physical bodies may now be expressed by two principles. The first principle is that a physical body is a center of reference of correlated perceptions. That physical bodies exist is confirmed by the discovery of functional relations between perceptions. The second principle is that the structure of perceptions indicates the structure of bodies. Its precise version in physics is that the coincidence of perceptions for all observers signifies the space-time coincidence of the events perceived. For mathematical exactness an event must be thought of as a space-time point.

The neutrality of the preceding formulation may be exhibited by giving two philosophical interpretations, dualistic realism and phenomenalism. In traditional dualism a physical body is absolutely independent of experience; it produces perceptions by acting on the observer. The structure of bodies is indicated in perceptions because the structure of an effect corresponds to that of the cause. In dualism the physical world is the object of a constructive hypothesis. The phenomenalistic interpretation is that a physical body is a conceptual parameter which serves to correlate perceptions; thus the physical world is the object of a constructive definition. Perception exhibits the structure of physical bodies in virtue of the mode of construction of the latter.

The issue between dualism and phenomenalism is not affected by the quantum mechanical theory of measurement. In this theory measuring instruments, such as a screen with a slit, are macrophysical bodies which are experienced in perception by classical methods. The properties of microphysical entities are determined from their effects upon the measuring instruments. In these determinations principles, such as those of conservation of momentum and energy, are employed to infer the properties of a microphysical entity. Now, the functional relations expressed by physical principles are to be viewed as constituents of physical reality. Hence the microphysical entity has the same kind of physical reality as the measuring instruments. If the latter are conceptual constructs to which possible perceptions are referred, so are the microphysical entities which interact with them. If the measuring instruments are independent realities in the dualistic sense, so are electrons and photons. The choice between these philosophical interpretations falls outside of physics. Indeed, some positivists hold that since the issue can not be decided by experience it is meaningless.

V. F. LENZEN

UNIVERSITY OF CALIFORNIA
BERKELEY

[1] SCIENCE, n. s., 85: 413, 1937.
[2] Nature, 136: 432, 1935.

FURTHER DISCUSSION ON SUBMERGED CANYONS

IN the April 3, 1936, issue of SCIENCE, MacClintock and the writer advanced a hypothesis that the submerged canyons off the coasts of all continents might be the result of a change in ellipticity of sea-level. F. P. Shepard[1] criticized this hypothesis, claiming to show that it was untenable because a zero line of no change of sea-level should exist at 35° N. and 35° S. latitude. Therefore the hypothesis could not explain valleys at higher altitudes than 35°.

Shepard's reasoning contains a fallacy. Two ellipses of the same area would intersect at 35°, but the two sea-level surfaces such as we suggested would not do so. The reason for this is that there is not enough water between 35° N. and 35° S. latitude to fill the volume up to the new spheroid above 35°; therefore the new sea-level surface would be parallel to the new spheroid but considerably below it. Thus the zero line of no change of sea level might lie at 55° or 60°, as we postulated.

The writer also wishes to take exception to Shepard's statement concerning the accuracy of soundings taken by the S 48. The writer was on the S 48 when these soundings were taken, and believes the accuracy was quite sufficient for the conclusions drawn.

The writer is not at all convinced that the change in ellipticity of sea-level hypothesis is the correct explanation for the origin of the submerged valleys, but he does still consider it a *working hypothesis*, even though it may be an "outrageous" one. If a solution is to be arrived at for this complex problem, all possible hypotheses must be kept in mind and the critical data bearing on all of them collected.

H. H. HESS

PRINCETON UNIVERSITY

[1] SCIENCE, June 26, 1936.

SCIENTIFIC BOOKS

THE ORGANIC CHEMISTRY OF NITROGEN

The Organic Chemistry of Nitrogen. By NEVIL VINCENT SIDGWICK, F.R.S. New edition. Revised and rewritten by T. W. J. Taylor and Wilson Baker. The Clarendon Press, Oxford, 1937; pp. xix + 590; 6½ × 10 in.; price, $8.50 bound.

THE new edition of this valuable treatise appears very appropriately in our own country only a few months prior to the arrival of its distinguished author, who is to deliver the Maiben lecture before the American Association for the Advancement of Science at its Denver meeting on June 23.

Since the appearance of the first edition, in 1910, the work has been recognized as an authoritative review and critical discussion of that great division of organic chemistry with which it deals. As explained at that time, the purpose of the book is primarily educational, and it is not intended in any sense as a work of reference. Hence it does not attempt to cover the whole vast domain of nitrogenous organic chemistry, but rather to select those portions which seem most important, either because of their theoretical interest or for other reasons, and to discuss these in considerable detail.

Professor Sidgwick realized many years ago that the enormous expansion of our knowledge in this field made a revision of his book highly desirable, and in 1922 began the undertaking, with the intention of enlisting the collaboration of some of his Oxford colleagues and thus making it a cooperative effort. By the close of 1933, he had completed the first draft of four of the eighteen chapters. It then became evident that the increasing duties and responsibilities of all kinds devolving upon him as the result of his selection for so many positions of honor and distinction would postpone indefinitely the completion of a task which was daily growing more difficult.

In 1934, therefore, the completion of the revision was entrusted to the capable hands of Drs. Taylor and Baker, both fellows of Oxford University, the one of Brasenose and the other of Queen's College, and the book under review is the result. In its compilation, the authors have had the benefit of the material accumulated by those other colleagues who, from time to time, had aided Professor Sidgwick.

The major grouping of the subject-matter into the four divisions—I. Compounds with no nitrogen directly attached to carbon; II. Bodies containing one nitrogen atom attached to carbon; III. Compounds containing an open chain of two or more nitrogen atoms, and IV. Ring compounds—has been abandoned, although, in the main, the chapter headings, sequence and subject-matter remain much the same. The text as a whole has been not only thoroughly revised but also largely rewritten. The book opens with an introduction by Professor Sidgwick on "The Nitrogen Atom," and "Resonance."

As compared with the first edition, the following changes will be noted: (1) the amino acids have been assigned a separate chapter; (2) the aliphatic diazo compounds and derivatives of hydrazoic acid have been removed from Division IV and now constitute Chapter XI, immediately preceding the hydrazine derivatives; semicarbazide and related compounds, formerly given in Division III, now appear with the other carbonic acid derivatives in Chapter IX; the uric acid derivatives and the pyridine alkaloids have been omitted. On the other hand, the discussion of quinoline derivatives has been considerably extended, and now includes such important topics as the cyanine dyes, reactive methyl groups, acridine and phenanthridine. In the chapter (VIII) on nitro compounds, Mr. D. L. Hammick contributed the section on the molecular complexes of aromatic nitro compounds, and Professor Sidgwick that on chelate *o*-nitrophenol derivatives.

To the literature of its field, it is an outstanding and valuable contribution, and one which should be in the library of every one interested in organic chemistry.

MARSTON TAYLOR BOGERT
COLUMBIA UNIVERSITY

LIFE HISTORIES

Criteria for the Life History, with Analyses of Six Notable Documents. By JOHN DOLLARD. Yale University Press. v and 288 pp. 1935.

IT is difficult accurately to review a book which is obscurely written. John Dollard has a large vocabulary which he uses with prolixity but without precision. For example, he quotes Adler as saying that the mother helps the child and usually pampers her, and he comments thereon (pp. 49, 51, 67) in a manner which indicates that he does not know what "pampers" means and thus misses the significance of the quotation. Again, he has a fondness for the plural noun "surrogates," but I am unable to substitute any definition of the term I have thus far found in the dictionaries for the word where he uses it. The proper use of shall and will, of should and would, is of course difficult even for a discriminating writer; yet without being too much of a purist one may feel that the readers at the Yale University Press might have clarified some of the author's sentences by querying his usage

of these common words. "The 'group' into which the child comes is not the group in general; the child is not born into the church or the army; rather he is born into a very definite specification of the larger group, namely, the family." Here the meaning is clear, despite the shock of the somewhat strange word specification; and one is perhaps impeded rather than helped in his comprehensions of the sentence if he should be unfortunate enough to think of the rites of infant baptism and of circumcision, or of the insistence of some large religious group that the child *is* born into the church.

John Dollard has an exuberance of metaphor. Sometimes he calls it metaphor, more often he does not. "To use a football metaphor we begin in Adler's psychology at about the thirty yard line, rather than at the goal line, so far as the biological contribution to the development of the individual is concerned." This does not seem clear; when did the football game begin at the goal line? Does it not begin at the forty-yard line? Would we turn from sports to biochemistry, kinematics and psychology we can ponder this: "It shows . . . the culture as coagulated around a center of feeling . . . the life history shows a center of feeling and positive motivation moving through a culture, over time. The culture offers to this moving center of feeling its preferred barriers and permitted exits, much as in the psychologist's maze." It is difficult to believe that for any reader this maze of metaphor in any way clarifies the author's meaning. He is surely trying very hard to say something, but what, or shall I say, which?

"Criterion II. The organic motors of action ascribed must be socially relevant. This criterion sounds rather difficult to understand, but this is not the case; it is really very simple. It means merely that in order to have a theory of motivation we must make some statements about the body and what it can and will do; the organic properties which we assume as the basis of the life in the individual in the group must be of such a kind that they will submit to social elaboration. The organic activities of the body must come to meet the social influences that we have described."

This, dear reader, appears to be the definition of one of the seven fundamental criteria which a life history must satisfy. The first sentence after the italics should be unnecessary if true; but let us be charitable and thank the author for encouraging us poor boneheads along. What, then, do you make of the next two sentences? Unhappily, I make little of them or of the following three pages of exposition of this "really very simple" matter, and I regret to say that after examining the application of the criterion to the six life histories analyzed by Dollard I am still at a loss to know what he means, if anything. In the first case history (p. 45) he writes: "Adler rejects inherited or inheritable traits as a necessary concept and sees the new born infant as completely and plastically accessible to social influence. In this he would seem to be quite in accord with the best results of the comparative study of culture." This is a strictly anti-hereditarian point of view. Yet somehow the whole aim of Criterion II seems to be to lay stress on the organic; it is at any rate the only criterion of the seven which deals with the body and what it can and will do. Of course if one distinguishes temperament and personality, including in the former everything that can be inherited and in the latter only that which is not inherited but is taken on by exposure to the culture, then, irrespective of the best results of the comparative study of culture, one rejects *by definition* the concept of inheritance in the study of personality—and if so, why not say so clearly, even bluntly.

This is indeed what Thomas and Znaniecki, as quoted by Dollard, seem to do: "We may call temperament the fundamental original group of attitudes of the individual as existing independently of any social influences; we may call character the set of organized and fixed groups of attitudes developed by social influences operating upon a temperamental basis . . . the development of temperamental attitudes into character-attitudes can assume many different directions, so that, if proper influences were exercised from the beginning, a wide range of characters, theoretically any possible character, might be evolved out of any temperament." This is tolerably definite. The biologist would probably object to so extreme a statement as "theoretically any possible character," but that might depend on how restrictive is the qualification "the set of organized and fixed groups of" applied to attitudes in the definition of character. At any rate, Dollard, writing after Thomas and Znaniecki, should be equally or more precise than they, whether he follows or modifies their definitions.

What Dollard is trying to do is to unite the notions of psychologist, anthropologist and sociologist in such manner that he may reach a specification of characteristics of the life history which shall be necessary and sufficient to make it define the growth of a person in a cultural milieu so that the life of the individual up to any particular point may be viewed as a connected whole, shall make theoretical sense as a unit and shall afford the basis for prediction of behavior immediately beyond that point. This is an ambitious project. To accomplish even initial stages in the development of such a difficult undertaking it is important to be discriminating in thought, straightforward in exposition, clear in phraseology. That is why I have laid

so much emphasis on his failure in these respects. He has shown that his criteria are not satisfied for the life histories he has examined, and presumably he has chosen for examination the best available. He may thus have made a real contribution to the improvement of future life histories, even though the work as a whole, especially in its all too frequent "asides" and in its exuberance of mixed metaphor, can hardly fail to impress any mature student as adolescent.

EDWIN B. WILSON
HARVARD SCHOOL OF PUBLIC HEALTH

SOCIETIES AND MEETINGS

THE ILLINOIS STATE ACADEMY OF SCIENCE

THE thirtieth annual meeting of the Illinois State Academy of Science was held at Rockford College, Rockford, Illinois, on May 7 and 8. The attendance at the meetings, including the sessions of the Junior Academy, which held meetings of its own at the Rockford Senior High School, was well over 1,000.

For the program at the general session on Friday morning, after an address of welcome by Dr. Gordon Chalmers, president of Rockford College, Professor C. L. Furrow, Knox College, Galesburg, president of the academy, gave an illustrated lecture on "The Evolution of Sex in the Mollusca." This was followed by an address by Mr. Don L. Carroll, of the State Geological Survey, Urbana, on "Some Observations on the 1937 Flood in Southern Illinois." This address was illustrated by lantern slides of aerial photographs and maps of the area. The final address of the Friday morning session was a lecture, illustrated by colored moving pictures, on "Science and the Garden" by Mr. John H. Hanley, University of Illinois, Urbana. The Friday morning session of the Junior Academy was given over to the display and judging of the projects which were presented for competition in the annual exhibition of projects. For the general session on Friday evening Professor H. A. Vagtborg, of the Armour Institute of Chicago, addressed the Junior Academy members and guests on the topic "The Story of Sanitation." Professor George W. Stewart, head of the department of physics of the University of Iowa, addressed the Senior Academy on the subject, "Changes in Concepts of States of Matter."

On Friday afternoon 145 papers were presented before nine sectional meetings. The activities of the academy for the Saturday sessions consisted of six field trips. These were especially well attended. The geological trip, under the direction of Dr. M. M. Leighton, chief of the State Geological Survey, Urbana, and of Dr. George E. Ekblaw, also of the State Geological Survey, visited points of geological interest in the vicinity of Rockford. An industrial trip, under the sponsorship of the Rockford Chamber of Commerce, visited some of the many interesting industrial plants at Rockford. A trip to the Rockford Sewage Disposal Plant was conducted under the leadership of Mr. T. G. Lindquist, superintendent of the Sanitary District of Rockford. An anthropological trip, with Dr. J. B. Ruyle, of Champaign, as leader, visited the Logan Museum of Beloit, Wisconsin, and studied the various kinds of Indian mounds in the vicinity. A trip under the leadership of Mrs. J. H. Mansfield, president of the Rockford Garden Club, visited some of the many fine residential gardens of Rockford, the public parks and the nine forest preserves of Winnebago County. The botanical trip, under the direction of Dr. H. W. Pepoon, Chicago, and Dr. George D. Fuller, of the University of Chicago, visited and studied the interesting flora of Apple River Canyon State Park.

The officers elected for the year 1937–38 are:

President, Harold R. Wanless, geology, University of Illinois; *First Vice-President*, George D. Fuller, botany, University of Chicago; *Second Vice-President* and *Chairman of Committee on Local Arrangements*, Otis B. Young, physics, Southern Illinois State Normal University; *Secretary*, Wilbur M. Luce, zoology, University of Illinois; *Treasurer*, Paul D. Voth, botany, University of Chicago; *Editor*, Dorothy E. Rose, geology, Illinois State Geological Survey.

The annual meeting for next year will be held at the Southern Illinois State Normal University, Carbondale, Illinois, on May 6 and 7, 1938.

WILBUR M. LUCE,
Secretary

THE NEW HAMPSHIRE ACADEMY OF SCIENCE

THE nineteenth annual meeting of the New Hampshire Academy of Science was held on May 28 and 29 at Colby Junior College, New London. The Friday evening session was devoted to the reading of papers by members, the principal one of which was "Physiography of the Mt. Washington Region," by Mr. Richard P. Goldthwait, of Harvard University, who has been working on the problem with the aid of a grant from the academy and from the American Association for the Advancement of Science.

Papers by members were read at the Saturday morning session. Professor Charles F. Brooks, director of the Blue Hill Observatory, Harvard, and of the Mt. Washington Observatory, reported on the work done at the Mt. Washington Observatory during the

past year, including the special studies aided by an academy grant from the American Association.

At the Saturday afternoon session following the business meeting the presidential address, "Vertebrate Evolution—A Record and Some Implications," was given by Professor George M. Robertson, of Dartmouth College.

At the business meeting it was announced that the council had recommended the awarding of the grant for the current year from the American Association for the Advancement of Science to Dr. Henry I. Baldwin, of the State Forestry Department, for assistance in compiling and publishing "A Flora of the Fox Research Forest." The committee on conservation, of which Mr. Laurence W. Rathbun, chief forester of the Society for the Preservation of New Hampshire Forests, is chairman, made a report of its activities and presented plans for further work.

The following officers were elected for 1937–38: *President*, Professor Karl W. Woodward, University of New Hampshire; *Vice-president*, Dr. Henry I. Baldwin, research forester, State Forestry Department; *Secretary-Treasurer*, Professor George W. White, University of New Hampshire; *Member of the Executive Council*, Professor George M. Robertson, Dartmouth College; *Councillor to the American Association for the Advancement of Science*, Professor Walter C. O'Kane, University of New Hampshire.

GEORGE W. WHITE,
Secretary

SPECIAL ARTICLES

THE BEHAVIOR OF CERTAIN DUSTS[1] UNDER MECHANICAL[2] IMPINGEMENT

ONE type of method for the examination of the dustiness of the air depends on the mechanical impingement of a known volume of the dust-laden air at a considerable velocity on a dry or wetted surface. From the number of dust particles found on a limited area of the dry surface or in a certain volume of the wetting liquid the number of dust particles in a unit volume of the sampled air is calculated. The possibility of breakage of the dust particles due to their force of impact on the impingement surface has been suggested from time to time, but as far as the writers know no investigations on this point have ever been published. If breakage did occur there would be more particles formed than were originally present, and furthermore a particle size determination on the resultant particles would show greater numbers in the smaller sizes than were present in the air.

So far we have used only three dusts in our experiments. Finely ground orthoclase feldspar and quartz were classified by settling in a mixture of water and ethyl alcohol. This method of classification has been described in detail by Cummings.[3] The fraction of each dust between 5 and 10 microns was resettled five times to remove adhering "fines." The third dust used was dried spores of pencillium oxalicum. The spores are uniform in size, averaging 2 microns in diameter by 4 microns in length.

Behavior of the three dusts under various conditions are given in Table 1.

TABLE 1

	Impinging velocity[4] meters per second	Conditions of impingement	Ratio of smaller particles to particles of original size (approx.)	Average dimensions of shattered particles microns
Feldspar	40 ± 10	Dry surface of gelatine and glycerine	4.5 : 1	1.0–1.5
Feldspar	70 ± 10	Dry glass plate[5]	100 : 1	1.0 and less
Feldspar	100 ± 10	Dry glass plate	100 : 1	1.0 and less
Feldspar	150 ± 10	Glass plate submerged in water	50 : 1	1.5 and less; considerable ultra-microscopic material
Pen. Oxal.	40 ± 10	Dry surface of gelatine and glycerine	0 : 1	None shattered
Pen. Oxal.	70 ± 10	Dry glass plate	0 : 1	None shattered
Pen. Oxal.	100 ± 10	Dry glass plate	0 : 1	None shattered
Pen. Oxal.	150 ± 10	Glass plate submerged in water	0 : 1	None shattered
Quartz	40 ± 10	Dry surface of gelatine and glycerine	3 : 1	1.0–1.5
Quartz	70 ± 10	Dry glass plate	25 : 1	1.0 and less
Quartz	100 ± 10	Dry glass plate	50 : 1	1.0 and less
Quartz	150 ± 10	Glass plate submerged in water	50 : 1	1.5 and less; considerable ultra-microscopic material

[1] The term "dust" is used to denote solid particles 0.5 to 10 microns in longest dimension.

[2] The term "mechanical" is used to denote a force caused mechanically rather than thermally or electrically.

[3] D. E. Cummings, *Jour. Ind. Hyg.*, 245–56, 1929.

[4] The velocities given above were obtained by dividing the volume of air sampled in a unit time by the area of

From the data in Table 1 it is concluded:

(1) The composition of the dust is a factor in the amount of *crushing* under mechanical impingement.

(2) The velocity of impact as well as the surface on which and the medium in which the impact occurs has a bearing on the amount of crushing.

(3) With the exception of impingement on a wetted surface, the smallest particles noted were on the order of a micron. It appears, therefore, there is a limit to the fineness that a particle will shatter at definite velocities and conditions.

(4) In the case of impingement on a wetted surface considerable material below 0.5 micron was noted. It may be that this was formed by attrition of the water-borne particles by other particles in the incoming air stream.

(5) In all cases of dry impingement a variable amount of scattering of particles outside of the field of impingement was seen. This indicates incomplete retention of these dusts on the impingement surfaces.

(6) With two of the three dusts any estimation of particle size distribution in the air from the resultant particles is erroneous.

(7) With each of the three dusts examined an estimation under the above conditions of the number of particles in the air sampled is erroneous.

J. B. FICKLEN
L. L. GOOLDEN
CHEMICAL ENGINEERING LABORATORY
TRAVELERS INSURANCE COMPANY

OVULATION INDUCED OUT OF SEASON

OVULATION has been induced in a variety of Amphibia during the non-breeding season by the injection of the anterior pituitary hormone. Since the original description of the technique of inducing ovulation and of artificially inseminating eggs of the frog, *Rana pipiens*,[1] there have been a number of refinements so that now one can count on securing fertilized eggs and developing tadpoles at any time of the year from early September until the normal breeding season, in March. From March until July, *Rana clamitans* can be used, and *Rana catesbeiana* (the bullfrog) will respond to pituitary-induced ovulation until late in August. *Acris gryllus* normally breeds from February to October, and *Rana sphenocephala* from February to December. With inhibition of normal ovulation by refrigeration, amphibian eggs may be available for twelve months of the year. The technique, as now used, will be briefly described.

With few exceptions, *Rana pipiens* can not be considered sexually mature unless it measures 74 mm from snout to cloaca. Frogs are secured from one of the frog farms and are placed immediately in a copper-lined tank in the refrigerator, through which runs a slow stream of water. Frogs may be kept at this temperature (about 4 to 6° C.) for several weeks without showing gonadal deterioration. Twenty-four hours before eggs are desired an obviously mature female is injected with whole anterior pituitaries from two adult female or four adult male frogs. Mammalian or fish pituitaries have not been successfully used with frogs in inducing sexual reactions, but such pituitaries will induce ovulation and amplexus in toads and breeding reactions in salamanders. Amphibian pituitaries will, in general, induce such reactions in *Rana pipiens*.

It has been found that the average male anterior pituitary (*Rana pipiens*) is 16 per cent. heavier and 60 per cent. as potent as the average female gland in respect to inducing ovulation. The glands must be quickly excised, as they rapidly lose their potency in dead frogs. If the head is cut off; the lower jaw removed; the base of the cranium cut along each side of the brain; the parasphenoidal bone deflected forward, the anterior pituitary gland will be seen as a pink organ lying just posterior to the optic chiasma. Occasionally it will adhere to the base of the cranium and will be surrounded by white endolymphatic tissue, which has no apparent sex hormone value. The pituitary is placed in 1 cc of distilled water, 35 per cent. alcohol or Ringer's solution. Generally 1 cc of fluid is used per gland, partly as a check on the number of glands used. When the proper number of glands has been secured, they are sucked up into the barrel of a hypodermic syringe, with no attempt to macerate the pituitaries. It has been found that the fresh gland will easily pass through a No. 20 hypodermic needle and that if the gland is previously macerated, some of the hormone is lost by adhesion to the inner sides of the syringe. The needle is applied to the syringe and injected through a lower quadrant of the abdomen, avoiding deep penetration and consequent danger of internal injury. Immediately following injection the frog is placed in a container with enough water to partly immerse the body. If amplexus and normal fertilization are desired, a male may be similarly injected and amplexus will be achieved in about 9 to 12 hours at ordinary laboratory temperatures of 22–25° C. In this case only pond or spring water, or 10 per cent. Holtfreter's[2] modification of amphibian Ringer's can be used, since tap water is generally lethal to sperm.

If insemination is to be controlled, the female should

the impingement orifice. The actual velocities at the surface where impingement takes place are of necessity lower, due to mechanical design.

[5] In all cases using a dry glass plate, the dust-laden air was previously humidified by passage through a tube containing moisture.

[1] R. Rugh, *Biol. Bull.*, 66: 22, 1934.

[2] J. Holtfreter, *Arch. f. Ent. Mech. der Org.*, Bd. 124, S. 404, 1931.

be kept isolated and 24 hours after injection should be tested (gently stripping) to determine whether eggs have reached the uteri. A sperm suspension (males need not be injected[3]) is made by teasing apart two pairs of testes in 10 cc of spring or pond water. It is very important to use only water in which sperm are known to survive. After about 30 minutes' standing, this sperm suspension is ready and eggs may be stripped directly into it. It is best to divide the suspension between two finger bowls and to spread the eggs out thinly in the sperm suspension. After half an hour the eggs are flooded with the same water used for the sperm suspension. When the jelly has swollen (about an hour more) the eggs should be distributed so that there are about 25 to 50 eggs per finger bowl full of water. In this manner 100 per cent. fertilization and development can be achieved under controlled conditions.

If a female is injected with the anterior pituitary hormone and is kept at 22°–25° C. it can be used in 14–16 hours to demonstrate all of the reproductive processes from follicle rupture to entrance of the egg into the uterus.[4] Such a frog should be anesthetized, opened, and the entire body submerged in 10 per cent. Holtfreter's solution. Ovarian contractions will be clearly seen. Numerous follicles will be observed to rupture and the eggs emerge, a process which takes from 4 to 10 minutes for a single egg. Free eggs will be picked up and carried toward the ostiae by peritoneal, pericardial and liver cilia. Eggs enter the ostium singly, entirely as a result of ciliary action. They are carried through the oviducts (about 2 hours) in a spiral manner, by ciliary currents. Eggs can be fertilized from any point within the oviduct but not from the body cavity. This situation is a challenge to further research on the mechanism of fertilization.

It has recently been demonstrated[5] that the dose of the anterior pituitary required to induce ovulation decreases appreciably in the period between November and February. This is explained on a three-fold basis: The potency of the donor's gland increases as the breeding season approaches; the gland of the recipient may begin the elaboration of the hormone toward the end of hibernation; and the ovaries may be differentially susceptible to stimulation at different periods.

The anterior pituitary is readily soluble in water and alkaline solutions. It can be kept in aqueous solutions for several days in the refrigerator. If kept in 70 per cent. alcohol the potency will remain practically unaltered for several weeks, and if kept in 100 per cent. alcohol, where none of the hormone is dissolved, the potency remains indefinitely. Recent tests have indicated normal potency after one year in absolute alcohol. In this latter case, however, the alcohol must be diluted with distilled water until a 35 per cent. solution (or less) is achieved before injection.

The frog's anterior pituitary is so small (0.6 to 1.5 mgm) that extraction of the hormone would entail great loss. Preservation of the entire gland is indicated. In most laboratories many frogs are sacrificed for a single muscle or nerve experiment and the anterior pituitary glands of such frogs may be excised and saved for ovulation induction during non-breeding seasons. There is evidence that this technique, with modifications, may eventually be used on a variety of animal forms which will yield valuable embryological material.

ROBERTS RUGH

DEPARTMENT OF ZOOLOGY,
COLUMBIA UNIVERSITY

Proc. Soc. Exp. Biol. and Med., 36: 418,

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ysiol. Zool., 10: 84, 1937.

HOMOTRANSPLANTATION OF ADRENAL CORTICAL TISSUE

IN 1932[1] we reported successful intramuscular homotransplantation of adrenal cortical tissue between albino rat litter mates (100 per cent. in four male rats). We also showed that both autoplastic and homoplastic transplants would grow in the same animal at the same time, there being no "preference" for either type of tissue (40 per cent. successful homotransplants in 10 male litter mates. Martin (1932)[2] also reported three successful homoplastic intraovarial transplants. Nilson and Ingle (1936)[3] reported that intra-ovarial homotransplants in sisters were successful, but that "direct homoplastic transplants of the adrenal glands of adult rats" and cross-strain transplants degenerated.

In connection with other problems it became necessary for us to attempt intramuscular homotransplantation of adrenal glands between non-siblings of our inbred strain of rats. The adrenal glands were exchanged between five pairs of females, three pairs of males and four pairs of a male and female each (24 rats). The members of each pair were not only nonlitter mates but were from different parents. Twelve animals died of suprarenal insufficiency. The twelve survivors were killed and the grafts examined histologically from two to four months after operation. The homotransplants had regenerated and were functioning (as testified by the good health of the animals) in eight of the ten females which had received tissue from other females, in two of the four females which had received tissue from males, and in only two of

[1] L. C. Wyman and C. tum Suden, *Am. Jour. Physiol.*, 101: 662–667, September, 1932.

[2] S. J. Martin, *Am. Jour. Physiol.*, 100: 180–191, March, 1932.

[3] H. W. Nilson and D. J. Ingle, SCIENCE, 84: 424, November, 1936.

the males. One of these had received tissue from another male and the other from a female. The sex of the donor, therefore, has no particular bearing on the success of non-sibling homotransplants. The sex of the recipient seems to be significant, since over 71 per cent. of the females regenerated homotransplants, whereas only 20 per cent. of the males did so.

Successful homotransplantation of adrenal cortical tissue between non-siblings of the same strain is possible. Obviously, if a large number of "takes" is desired in such experiments females should be used. We have evidence, which will be published elsewhere, that the growth of transplanted cortical tissue in rats is determined and limited by the available adrenotropic hormone from the anterior lobe of the hypophysis. The larger percentage of "takes" in females reported here may depend on a greater amount or greater availability of adrenotropic hormone in females. Such an explanation is consonant with the well-known facts that female rats have larger adrenal cortices than males, and that females regenerate more cortical tissue in transplants or "accessories" than do males.

LELAND C. WYMAN
CAROLINE TUM SUDEN
BOSTON UNIVERSITY SCHOOL OF MEDICINE AND THE EVANS MEMORIAL, MASSACHUSETTS MEMORIAL HOSPITALS

IMMUNITY OF CERTAIN INSECTS TO SELENIUM POISONING

A LOW concentration of selenium in foodstuffs is a quick-acting lethal poison for mammals and birds, and small quantities of this element absorbed from the soil are responsible for toxicity of grains and forage plants to live stock.[1] Insects also are regarded as very sensitive to selenium. Aphids are killed by concentrations in wheat plants too low to injure the plants themselves,[2] and red spiders are quickly destroyed by commercial insecticides containing selenium.[3]

We were surprised, therefore, to find weevils and seed-chalcids completing their life cycles in the seeds of one of the most poisonous of the range plants, *Astragalus bisulcatus* (collected near Laramie, Wyoming). Analysis showed that the seeds contained 1,475 parts per million of selenium. The weevils were identified by Mr. H. S. Barber as *Acanthoscelides fraterculus* (originally reported from Kansas, Nebraska and Colorado) and the seed-chalcids—small wasp-like insects—were identified by Mr. A. B. Gahan as *Bruchophagus mexicanus* or a closely related species. A second hymenopterous insect, *Amblymerus bruchophagi*, less numerous than the first, was present as a parasite of the seed-chalcid.

The high toxicity of the seeds to mammals was shown in an experiment in which five white rats were fed on a mixture containing ground pods and seeds of a similar *Astragalus* plant. Although the selenium content of the food was reduced by dilution with ground wheat to only 65 ppm, the rats were killed within from 4 to 11 days. Even 22 ppm of selenium in the diet is lethal to young, developing rats;[4] and grains and fodder containing less than 50 ppm of selenium absorbed from the soil have been reported to cause the death of hogs, cattle and horses.

The *Astragalus* plants, though rooted in soil with a selenium content of only about 3 ppm, are able to accumulate from 1,000 to 9,000 ppm.[5] The developing weevil larvae present a striking contrast: Although their food contained 1,475 ppm of selenium, the larvae either did not absorb it readily or they eliminated it effectively, perhaps through their respiration. Analysis of their bodies showed the presence of only 65 ppm of selenium.

SAM F. TRELEASE
HELEN M. TRELEASE
LABORATORY OF PLANT PHYSIOLOGY
COLUMBIA UNIVERSITY

[1] For literature review, see S. F. Trelease and A. L. Martin, *Bot. Rev.*, 2: 373–396, 1936.

[2] A. M. Hurd-Karrer and F. W. Poos, SCIENCE, 84: 252, 1936.

[3] C. B. Gnadinger, *Indust. Eng. Chem.*, 25: 633–637, 1933.

[4] A. L. Martin, *Amer. Jour. Bot.*, 23: 471–483, 1936.

[5] O. A. Beath, H. F. Eppson and C. S. Gilbert, *Wyo. Agric. Exp. Sta. Bull.*, 206, 1935.

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COMMUNICATION ENGINEERING[1]

By Dr. FRANK B. JEWETT
BELL TELEPHONE LABORATORIES

IN most respects the history of electrical communication and of the engineering on which it rests is typical of the history of all great modern industries based on science and which did not originate in the unrecorded and presumably accidental experiences of our remote primitive ancestors. The development of electrical communication in all its branches discloses the typical sequence of one or more phenomena disclosed by fundamental science research appealing to a man or men with some understanding of science and possessed of the inventor's imagination and urge to create new things of practical utility. Once the trail is blazed there follow in succession the eras of development, first by other inventors, then by engineers who know more of science than the inventors but who rarely create essentially new knowledge, and finally the era in which development is mainly in the hands of research men and engineers working in intimate cooperation.

All branches of electrical communication—land line and submarine cable telegraphy, radio transmission, whether for telegraphy or telephony, and telephony by whatever means the signal impulses are transmitted or for whatever purposes employed—have gone through the several cycles. Further, they have spread out in this last era to embrace the art of permanent recording and subsequent reproduction of sound and much of the field of acoustics. In all these fields the major advances in the future over the present art are to be looked for in the research laboratory. Mainly I surmise these advances will emanate from the industrial research laboratory, although in the future, as in the past, revolutionary concepts are likely to originate in the laboratories of fundamental science and be brought to fruition in those of industry.

All forms of electrical communication are at base

[1] Address delivered at the symposium on recent progress of science in connection with the dedication exercises of the new building of Mellon Institute, Pittsburgh, May 7,

variant offshoots of common root stock. All require terminal apparatus to transform signal impulses into electrical impulses or the reverse; all require some form of conducting medium for these electrical impulses, either guided as in the case of wire transmission or broadcast as in radio, and all to a greater or less degree employ switching mechanisms, either manual or automatic.

Due to the nature of the impulses it must manipulate; to the necessity for simultaneous two-way transmission; to that of essentially instantaneous establishment on demand of connection in any random fashion between any two of an enormous number of terminal stations and because of the sheer magnitude in number of these connections made each day, the scientific and engineering problems of telephony are far greater and more complex than those of all other branches of electrical communication put together. Further, solution of problems in telephony rather automatically solve many problems in the less general cases which arise in the other branches.

Because of these facts and since the time available in this symposium is limited, I shall confine discussion to the field of two-way telephony as being typical and to a large extent though not wholly inclusive of the other fields of electrical communication.

About thirty years ago it became increasingly apparent that telephone development had outrun the possibility of large future advance wholly under the guidance of the inventor and engineer. The problems ahead, whether of terminal apparatus, transmission, switching or of economics, were such as to demand the attention of men thoroughly acquainted not only with current advances in the basic physical sciences but likewise with the powerful methods of investigation which were producing new knowledge. The urgency of many of the problems made it imperative both that all existing knowledge be scrutinized and employed when available and that new leads be developed more rapidly than was to be anticipated from the unorganized attack of individual investigators.

It was from the necessity of this situation that the beginning of industrial research as we now know it began in the field of electrical communication. Progress was slow at first, partly because it was a radically new approach little understood by those who had carried on successfully the previous development work and who were naturally skeptical; partly because it was difficult to know where and how best to start the attack, and largely because there were then very few suitable trained men available. Initially, judged by present-day criteria, much of the work, although scientific, was rather gross. Partly this was due to the nature of the existing structure on which we had to operate. Largely it was due to an almost complete absence of proper tools and techniques with which to work. The present-day research man in a well-equipped communication laboratory can have little conception of the difficulties which confronted his predecessors in their attempts to solve high frequency problems without any high frequency generators, shielded bridges, unbalance sets, amplifiers or the hundred and one other laboratory tools which are now the commonplaces of everyday use. Actually for many years in the early days of research laboratory development a large part of the time and effort of the staff was devoted to the creation of investigating and measuring tools.

Gradually, but with accelerated speed, the picture changed until now the research laboratory is fully recognized in the communication field to be the center from which come not only the advances in the art but also the basis for the engineering and operation of the new things it creates and the new methods it evolves. Subtract all or even a substantial part of the research laboratory and progress in communication would not only stop but the art would tend to retrograde and service to deteriorate. Present-day electrical communication is so completely a thing of intensely applied science and is pressing so closely on each new discovery in fundamental science in certain fields that it can only exist serviceably in an expanding world through continued application of the methods which have brought it into existence.

Parallel with the growth of the research laboratory and with its increasing power to solve difficult problems, to expedite the utilization of each new piece of knowledge and to produce new things, methods or services has been an expansion of the fields of science into which its energies have been directed. Each advance has added to the possibility of still further advances and to the necessity for greater nicety in making those advances. Any major problem to-day is certain to require consideration of a wide variety of matters in the field of the physical and mathematical sciences and not infrequently of the biological as well. Hence we find a large amount of research work going on which at first sight seems to have little if any relation to electrical communication.

This tendency to expand the area of research interest and attack seems destined to continue. Already a very intricate and delicate structure, the telephone plant is becoming each day more intricate and delicate as it grows in size and diminishes in unit fundamental cost. Each day the premium on integrity of operation increases and the importance of having full knowledge of every factor which can affect that integrity is enhanced. The telephone plant is a vast completely integrated structure designed for but a single thing, namely, to provide a reliable service for the most in-

tangible thing in the world—the transmission of human thought. Being vast and completely integrated insignificant failures which elsewhere would at worst produce only moderate localized dislocation may here create disruption and disorder in distant places. A slowly acting but unsuspected chemical or physical reaction which in time will produce corrosion or disintegration of a vital contact or the failure of a crucial vacuum tube filament may throw into confusion a large part of the traffic over some important route or interrupt service across a continent or between continents.

It is because of this integration and complexity, combined with the magnitude of the multipliers involved, that research work in telephony is elaborate and conservative to an extent seldom if ever required elsewhere. Nothing of importance is ever standardized for general use in the telephone plant of the Bell System until it has undergone every laboratory test (including extensive service trial installations) which the ingenuity of trained scientists and engineers can devise. The penalties of failure are too great to do otherwise—we *must* know everything that present scientific knowledge enables us to know about each element of a new structure or system that is likely to affect operation during its service life.

There is no scintilla of doubt that our present electrical communication systems owe their existence to the research laboratory and to the engineering based on its work. Much of what they comprise could never have come into existence at all without the aid of highly organized industrial research laboratories. As for the rest, which was the art before they came into being, the costs incident to rising material and labor prices and to the inherent increase of cost with size in a telephone plant would have greatly limited growth. Thanks to the research laboratory we have thus far been able to offset these factors and it continues to be our hope for the future.

Now, in conclusion, a very brief survey of our present situation and of what the future seems to hold in store for communication research and engineering. The forward picture is quite different from what it was a few years ago when there were still geographical distances to be conquered or types of service which could not be given for lack of physical means.

The ultimate goal of telephone service is to give substantially instantaneous connection on every random demand, over a plant that is as nearly as possible 100 per cent. reliable and of essentially perfect transmission quality and at a cost which will insure maximum use—all within the limits of that financial safety without which no adequate service can be guaranteed or even provided. With no barrier of terrestrial distances now existing which can not in some fashion be spanned by telephone channels if need arises, and with every major element which controls the giving of random two-way telephone service at least partially developed, the problems of research and engineering in the years ahead are essentially the problems of a better cultivation of the entire field, to the end that the ideal goal can be more nearly attained.

If essentially instantaneous compliance with the random demands of millions of subscribers for telephone connections is to be met it means that the telephone plant must be adequate to handle the offered service at times of peak desire. Since the need and desire to telephone is controlled by the normal necessities of life and the established business and social habits of people and not by those who provide the means for rendering service, and since experience has shown that the periods of peak demand occupy but a limited portion of each twenty-four hours, any approach to the ideal means inevitably a provision of plant so profuse that a very large part of it must be idle a majority of the time. Such a condition can only obtain within those limits of reasonable cost which will insure maximum availability to those who would employ the service if the inherent unit costs of the plant are low. In other words, the conditions require that many elements must be provided at a cost not greater than that which could be justified for a single element which would be capable of handling all the traffic if this traffic were substantially uniformly distributed throughout the entire twenty-four hours.

As a result of the work thus far done in the research laboratory substantial progress toward the attainment of the ideal has already been made. Further, if additional progress is to be made the research laboratory is practically the only place to which we can look for the facilities and methods which will be required. There is every present reason to believe that continuation of organized research work along the lines which have proven so fruitful in the past can be depended upon to carry us a long distance beyond where we now are. This continuation will require an increasing amount of attention to details whose influence and effect in a less developed state of the art are masked by grosser limitations.

Merely by way of illustration, since somewhat corresponding examples can be selected from almost any area, I would call your attention to what concentrated organized research has thus far done and is now doing in the direction of providing transmission channels in profusion.

Without going back to the time when open wires on poles with one pair of wires for each channel were substantially the only means available for connecting subscribers together, we are but little removed from the time when, whether as open wires or as pairs of

wires in cables, an actual physical circuit had to be provided for every connection that was made. The advent and development of loading coils and amplifying devices, both products of the laboratory, did not alter this necessity, although they did increase the distance over which communications could be given economically.

Until fundamental science, much of it involving new knowledge, was, through the coordinated work of industrial research, directed to the problem of extremely low-cost channel provision, there was essentially only one known way of providing a multitude of non-interfering channels along a common route. This was to assume that the electrical impulses over each channel were essentially alike and by means of geometrical and mechanical arrangement to reduce to a minimum the deleterious effects of transfer of energy from any circuit to its neighbors.

Recently, however, thanks to the research laboratory, operating in a myriad of fields and with organized utilization of the results in these fields, an entirely different method of providing large numbers of channels has been achieved and the way opened to an unknown indefinite extension. There is no time here to elaborate the niceties of the method. It is sufficient to say that it is what has commonly come to be designated as the carrier method, by which a single physical circuit can be made to transmit simultaneously a large number of non-interfering conversations by means of apparatus which is relatively simple and reliable and whose cost when apportioned among the several channels provides these channels much more economically than was possible under the older art. While there are definite limitations in the field of use of this method, it bids fair to have wide application over the longer distances. In its most advanced application, namely, that of the so-called coaxial cable, which is now undergoing trial in an experimental installation between New York and Philadelphia, many hundred telephone conversations can be carried on over a single pair of physical channels.

Achievement of this and similar less spectacular results imposes a burden of extreme nicety and reliability on the functioning of many devices, since failure of any one will disrupt not a single conversation but a multitude of conversations. That such multiple transmission can even be contemplated seriously is high tribute to the power of scientific research which makes it possible.

Broadly speaking, the main emphasis of all research in the telephone field is directed toward the goal of producing terminal apparatus, switching mechanisms and channels of communication of great reliability and minimum cost, both first cost and cost of operation and maintenance—all to the end that facilities can be provided in the profusion needed for a uniform no-delay service at an expense to the subscriber which will have minimum tendency to restrict usage where telephony is the indicated preferred method of communication.

In two of the main sectors, namely, those of switching and trunk channels as between central offices or between cities, the purely technical problems of unit cost reduction are frequently made somewhat easier by the fact that certain of the elements lend themselves to wholesale treatment. In much of the third sector, however, namely, that of local distribution to the subscriber, the case is essentially one of dealing with a retail problem. Here, even if the equipment itself and the channel connecting it to the central office could be furnished at extremely low cost, there would still be a substantial item of investment involved in the fact that installation and maintenance cost would be relatively high. Even here, however, it is to the research laboratory that we must look for most of such help as it is to be anticipated.

EARLY WORK ON INSULIN[1]

By F. G. BANTING, M.D.
UNIVERSITY OF TORONTO

I first wish to thank the Mellon Institute for their kind invitation to be present on this occasion. I wish also to congratulate you on this fine new research laboratory. It is a monument to the Mellon family and also a monument to the successful work of the institute in the past.

Although I have heard much of the Mellon Institute it was not until I read the book of your director that I understood the true significance and scope of your endeavors. May I express the hope that your future activities will be crowned with equal or even greater achievement.

It was with great pleasure that I observed that the Mellon Institute is including in its activities certain problems in medical research. It is to be hoped that you will undertake research on other major problems in medicine and that you may even organize an attack on cancer.

The field of medical research is so wide that it is necessary to specialize. I did not therefore feel that I could adequately cover the field of internal secretions,

[1] Address delivered at the symposium on recent progress of science in connection with the dedication exercises of Mellon Institute, Pittsburgh, Pa., on May 7, 1937.

as requested in your invitation, but asked that I be allowed to speak on the internal secretion of the pancreas.

This task is more difficult than might be thought, because it is now fourteen years since I have done experiments on the internal secretion of the pancreas. I have, however, retained an active interest in the subject of diabetes. A very great deal of research had been done on the pancreas previous to 1920. It was known that there were two types of cells. One group, called acinous cells, produce powerful enzymes which are poured into the intestine for the digestion of food. These cells produce the external secretion. The other cells are fewer in number and occur in groups and are called the "Islands of Langerhans." These are the cells which produce the internal secretion.

It was known that the extirpation of the pancreas resulted in diabetes. It was also known that if the pancreatic duct was tied there was an atrophy of all the glandular cells which produce the external secretion, but the animal did not become diabetic. Many investigators had tried to make active extracts of the pancreas that would be of value in the treatment of diabetes.

The original hypothesis on which the work on insulin was based was that the enzymes of the cells of external secretion destroyed the active anti-diabetic product of the cells of internal secretion. Our whole effort was directed, therefore, to eliminating the destroying substances. We first ligated the pancreatic ducts in a number of dogs, waited some weeks for the acinous cells to degenerate, then removed and extracted the remaining cells. This extract was tested on a dog that had been rendered diabetic by removal of its pancreas. It was found that extracts made in this way contained an anti-diabetic substance, since they improved the clinical condition of the animal and decreased the amount of sugar in the blood and urine. Active extracts of the pancreas were also made by exhausting the glands of external secretion and thus getting rid of their destroying enzymes.

It was then found that an extract made from the pancreas of foetal calves of under 4 months' development contained a powerful anti-diabetic substance. Finally we found a chemical means of extracting the active anti-diabetic substance from the whole adult pancreas of the abattoir animals.

The production of a purified product then became the problem of the chemist. To Best, Collip, Shaffer, of St. Louis, and Clowes, of the Eli Lilly Company, must be given the credit for the early work on the purification. I would like to again pay tribute to the admirable cooperation of Dr. G. H. A. Clowes and his research group of the Eli Lilly Company in the early struggle in extraction, purification and large-scale production of insulin.

From experiments on animals it was found that the physiological derangements caused by the removal of the pancreas could be corrected by the administration of insulin. It was proved that the increase of sugar in the blood could be lowered to normal or even subnormal levels; that sugar could be stored in the liver as in a normal animal; that whereas a diabetic dog can not burn sugar, it could be made to do so when insulin was administered; all the signs and symptoms of diabetes could be relieved; and the life of the depancreatized dog could be prolonged. Thus it was believed that insulin was the internal secretion of the pancreas and that its administration would relieve the symptoms of diabetes.

From this knowledge of the experimental work on animals we were able to predict the result of administering insulin to humans. One of the main factors in this prediction was that of diet. It must be remembered that when insulin was first used clinically diabetes was being treated by diet. Both patients and doctors had fixed ideas concerning what they should eat. Some were taught that diabetics should starve until they became sugar-free and then eat weighed amounts of fruits and vegetables which contained small amounts of sugar; some followed the high fat diet, while others used a combination of these two.

The pancreas of all diabetics, regardless of the severity of the disease, produces some insulin. Taking into consideration the variations in diet, the object of the treatment was to supply insulin in just sufficient amounts to compensate for the deficiency in the patient's pancreas.

From the physiological point of view there seemed no reason why a diabetic should not eat a normal diet. As early as August, 1922, one of our most severe diabetics was given a diet which included bread and potatoes and was kept sugar free by the use of insulin. When a group of diabetic specialists visited Toronto in November of that same year they would scarcely believe the records of this patient.

The time of administering insulin is an important factor. In order to have its action concurrent with the absorption of food it is advisable to give the injection 20–35 minutes before a meal.

If too much insulin was given we observed in the humans, as had been previously found with animals, that the blood sugar fell to subnormal level. This fall in blood sugar was accompanied by symptoms which we now call insulin shock. The administration of glucose caused a rapid return of the blood sugar level to normal and relieved the symptoms.

One of the most dreaded complications of diabetes

was coma. This condition was explained by saying that "fats only burn in the fire of carbohydrates." When the production of acetone bodies—aceto-acetic, beta hydroxy-butyric and acetone—become greater than the excretion these ketone bodies accumulate, producing drowsiness and coma. Previous to insulin coma was a common occurrence. Now I believe it is less common. Insulin was specific for coma, since it caused sugar to burn and with it the fats were completely oxidized.

Another complication of diabetes that was met with in the older patients was gangrene. In the pre-insulin days operation was dangerous and the patients usually died following the operation. Now diabetics can be safely operated upon because insulin controls the blood sugar and acetone production.

The early clinical results were obtained from an insulin which we now know contained impurities. Biochemists took up the problem of purifying the product. Abel, of Baltimore, in 1926, was the first to prepare insulin in crystalline form. The medium from which he obtained his crystals contained ammonium acetate, brucine and pyridine. The isolation of the crystals was attributed to the fact that the acidity could be adjusted to the isoelectric point of insulin, so slowly and so accurately that a supersaturated solution was obtained. Scott, of Toronto, working with Harington, of London, obtained crystals from amorphous insulin using a buffer solution of ammonium acetate and saponin. The yield of crystals produced by these methods was irregular.

On searching the literature Scott found that the pancreas contained considerable quantities of zinc (according to Lutz) and of cobalt and nickel (according to Bertrand). He then found that when traces of zinc were added to a buffered solution of amorphous insulin crystals were readily obtained. He explained the results of the saponin crystallization by the fact that the saponin contained zinc as an impurity. On examination it was found that Abel's crystals also contained zinc. Scott proceeded to test large numbers of metals and found that cadmium, nickel and cobalt could also be used in the crystallization, but were less satisfactory than zinc.

In the meantime, refinements were introduced into the methods of production of the insulin that was being used clinically. With the elimination of impurities the insulin was more rapidly absorbed and the duration of its effect was lessened. This made it necessary to increase the number of doses in order to maintain a patient free from sugar. Since insulin could only be taken by hypodermic injection the result was an added inconvenience to the patient.

Hagedorn, of Denmark, sought to prolong the effect of insulin by adding protamine, which was obtained from sperms of rainbow trout and mackerel. Hagedorn and his colleagues, 1933–35, found that the addition of protamine to their insulin so delayed the action that the day's supply of insulin could be given in one injection. This was the greatest advance in the treatment of diabetes since the discovery of insulin. Scott found that when protamine was added to zinc-free amorphous insulin, there was little or no delay in the rate of absorption. If, however, zinc was added a combination occurred between the insulin and protamine with the characteristic slowing effect of the protamine. It would seem that the Danish insulin contained sufficient zinc or other specific metal to produce this combination.

Ordinary insulin, as used in Canada and the United States, is made by dissolving amorphous product which contains from 16 to 20 units per milligram. Protamine zinc insulin is made by adding definite amounts of zinc and protamine to ordinary insulin. By the addition of zinc to a solution of amorphous insulin 89 to 90 per cent. can be crystallized. Crystalline insulin has a potency of 23 units per milligram.

Another modification is being tested, namely, zinc alone to insulin. Scott had found in dogs that there was a prolonged blood sugar lowering effect following the injection of zinc insulin. This insulin is now being tested clinically by Dr. Hipwell, who has found that the effect of zinc insulin is intermediate between regular insulin and protamine insulin. It is too early to speak of the clinical value of this form of insulin.

The original hypothesis was that insulin could not be extracted from the pancreas because it was destroyed by the pancreatic juice. It is interesting to note that even the most purified insulin is digested by both trypsin and pepsin. Insulin is a protein from which nine amino acids have been isolated. In the digestion of insulin the total activity is lost when only 25 per cent. of the protein has been split.

Dudley, Rosenheim and Rosenheim found that the insulin prepared by the picric acid method contained spermine. This spermine was found to be a normal constituent of pancreas. Lutz found that the pancreas contained zinc. It may have been the presence of these substances in pancreas which resulted in the slow action of the early insulin preparation.

The chemistry of insulin has been extensively investigated; the clinical application has been widely accepted. It is estimated that over one million people receive insulin each day. Although much of the physiology is known, we do not yet know how insulin enables the body to utilize carbohydrates nor do we know the cause of diabetes.

OBITUARY

E. P. BURRELL

THE world of engineering and of science, particularly astronomy, has suffered a great loss in the untimely death of Mr. E. P. Burrell, director of engineering of the Warner and Swasey Company of Cleveland, makers of machine tools, but especially famous as builders of many of the world's great telescopes. Mr. Burrell was trained at Cornell in engineering, and while his work with the company was primarily as a designer and director of construction in its well-known line of turret lathes and other machine tools, it is chiefly in connection with his later work in the design and construction of modern reflecting telescopes that this note of appreciation of his many fine qualities of mind and heart attempts to deal.

Mr. Burrell's first essay in the design of large telescopes occurred in 1913 when the Warner and Swasey Company was awarded the contract by the Canadian Government for the mounting of a 72-inch reflecting telescope to be erected at Victoria, B. C. The details of the design were beautifully worked out by Mr. Burrell, who showed no less than genius in developing the mechanism required for the operation of the telescope in the most suitable and efficient, and at the same time, in the simplest possible form. It was the first telescope in which the polar and declination axes were wholly carried by self-aligning ball bearings and in which the motions were electrically operated and controlled. The completed telescope, in simplicity and beauty of design, in accuracy of construction and in speed and convenience of operation, as yet unsurpassed by any working telescope, and which has been in successful and fruitful use for nearly twenty years, forms a great tribute to Mr. Burrell's engineering ability and skill in design.

This was followed shortly afterward by the 69-inch Ohio Wesleyan telescope similar in form, but with improvements in detail. But the masterpiece of the Warner and Swasey Company and of its designer, Mr. Burrell, is undoubtedly the 82-inch reflecting telescope of the McDonald Observatory, Texas, now approaching completion. The specifications were exacting, requiring the utmost ingenuity and perseverance to fulfil. Some of the original features worked out by Mr. Burrell include a greatly shortened declination axis, permitting the Coudé beam to be reflected down the polar axis; duplicate elevating platforms, enabling the Cassegrain focus to be readily reached in any observing position, also serving for resilvering and changing accessories; a simple and convenient method for changing the secondary mirrors, and a special vacuum tube type of electric drive. This mounting, now installed in its dome, sets a new standard in accuracy and convenience of operation.

No man can have a finer monument than these great telescopes for which Mr. Burrell was mainly responsible, nor can any man have a more enduring memorial than that provided by the work they are doing and will continue to do in adding to our knowledge of the universe. These speak in no uncertain tones of Mr. Burrell's outstanding scientific and engineering ability, but they fail to reflect another aspect of his character, his kindly and lovable personality. His many friends will sincerely mourn his passing and will cherish dearly the memory of his charity, patience and other lovable qualities of mind and heart, even more than his great intellectual attainments.

J. S. PLASKETT

DOMINION ASTROPHYSICAL OBSERVATORY,
OTTAWA, CANADA

RECENT DEATHS

DR. AMBROSE SWASEY, of the firm of Warner and Swasey, of Cleveland, manufacturers of telescopes and instruments of precision, died on June 15. He was ninety years old.

DR. W. T. MATHER, professor of physics at the University of Texas, died suddenly on June 14 at the age of seventy-two years. He had been a member of the faculty for forty years.

DR. HARRISON PRESCOTT EDDY, sanitary engineer of Boston, died suddenly on June 15 at the age of sixty-seven years.

DR. HANSFORD M. MACCURDY, professor of biology at Alma College, died on June 21. He was in his seventieth year.

JOHN M. CONDRIN, associate professor in the department of biology of the University of Toledo, died on June 9 at the age of thirty-two years. A correspondent writes: "He had been a member of the department since 1927. He was a graduate of Western Reserve University and received the M.A. degree from that institution in 1927 and was just completing work for his doctorate at the University of Michigan. He was a member of several national zoological societies and of both the Ohio and Michigan Academies of Science. He was the author of several publications on nudibranchs, genetics of pigments in mollusks and the physiology of hibernation in mammals."

SCIENTIFIC EVENTS

THE LINNEAN SOCIETY OF LONDON

ACCORDING to an account given in *Nature* of the anniversary meeting of the Linnean Society of London, which was held on May 24, the title of the presidential address of Dr. W. T. Calman was "James Eights, a Pioneer Antarctic Naturalist."

The Linnean Gold Medal was presented to Dr. F. F. Blackman, formerly reader in botany in the University of Cambridge. In making the presentation, the president said that the modern period of research on some of the fundamental problems of plant physiology began with the medallist's "Experimental Researches in Vegetable Assimilation and Respiration" in 1896. These "Researches," carried on with the aid of students, now number twenty-one, and recently a new series, "Analytical Studies in Plant Respiration," has been added. In 1905 Dr. Blackman published a paper entitled "Optima and Limiting Factors," which is a landmark in the study of the influence of external factors on physiological processes. The Trail Award of the society "to encourage study that throws light on the substance known as protoplasm, or the physical basis of life" was made to Dr. C. F. A. Pantin, Harding lecturer in zoology in the University of Cambridge, for his work on the mechanism of amoeboid movement showing that the protoplasmic changes involved are fundamentally similar to the processes which go on in cilia and in muscle.

The following were elected officers of the society for the year 1937–38: *President,* John Ramsbottom; *Treasurer,* Francis Druce; *Secretaries,* I. Henry Burkill and Martin A. C. Hinton; *New members of Council,* I. Henry Burkill, Miss M. L. Green, Dr. H. S. Holden, Fred Howarth and Professor F. E. Weiss. *Foreign members* elected were: Dr. Reinhard Dohrn, director of the Marine Biological Station, Naples; Dr. Herman Augustus Spoehr, director of sciences at the Division of Plant Biology of the Carnegie Institution, Stanford University; Professor Erick Anderson Stensiö, director of the Riksmuseets Paleontologiska Avdeling, Stockholm, distinguished for his researches on Old Red Sandstone fishes; Professor Nils Eberhard Svedelius, director of the University Institute at Uppsala and treasurer of the Swedish Linnean Society, known for his contributions to the knowledge of the taxonomy, morphology and life-histories of marine algae; Dr. Richard Woltereck, for many years professor of zoology in the University of Leipzig, and until recently director of the Zoological Institute, Ankara, Turkey. Professor Woltereck is known for his work in limnology. He organized and was the first director of the Freshwater Biological Station at Lunz in Austria and has been editor of the *Internationale Revue der Gesamtes Hydrobiologie und Hydrographie* since its commencement in 1908.

ST. LOUIS MEETING OF THE EASTERN SECTION OF THE SEISMOLOGICAL SOCIETY OF AMERICA

THE twelfth annual meeting of the eastern section of the Seismological Society of America was held at St. Louis University on June 11 and 12. Although this is the first time that the section has met so far west since plans for its organization were first made in St. Louis more than ten years ago, a representative group attended.

All sessions and the business meetings were held in the Commerce and Finance Building of the university. A brief address of welcome was given by the Rev. T. M. Knapp, S.J., chancellor of the university.

After attending to the usual business of the society, the reports of the chairmen of the various standing committees were given; of these, that by Rev. J. B. Macelwane, S.J., on amateur seismology was the most discussed. Plans were outlined to stimulate further the interest already manifest and to distribute information and a list of references on the construction and operation of amateur seismographs. Hope was also expressed that more space might be obtained in popular scientific magazines for publishing the activities and latest developments of amateur seismologists.

Colombia, South America; Ontario, Canada; the District of Columbia and the states of Texas, Alabama, Missouri, New York and Massachusetts were represented in the twenty papers that were presented following the business meeting.

On Saturday morning officers for the ensuing year were elected as follows:

Chairman, E. C. Jacobs, of the University of Vermont, Burlington, Vt.

Vice-chairman, H. E. McComb, of the U. S. Coast and Geodetic Survey.

Secretary, A. J. Westland, S.J., of the Department of Geophysics, Saint Louis University.

Treasurer, A. C. Chick, of Providence, R. I.

Fifth member of the Executive Committee, L. B. Slichter, Massachusetts Institute of Technology.

On Friday evening the members as a group attended a performance of "The Great Waltz" at the Municipal Open Air Theater. On Saturday, after a luncheon in the Pine Room of the Coronado Hotel as guests of the university, the group divided into two parties; the one visiting the Chester Illinois land slide, sixty-five miles southeast of St. Louis, and the other the Florissant

Seismological Observatory and the estate of Joseph Desloge on the Missouri River.

A. J. WESTLAND, S.J.,
Secretary

THE PROPOSED AMERICAN ASSOCIATION OF APPLIED PSYCHOLOGY

PROPOSALS for the organization of an American Association of Applied and Professional Psychology have been issued by a national committee, and a program of professional activities and applied research is planned for August 30 and 31 at the University of Minnesota in connection with the annual meeting of the American Psychological Association. All psychologists concerned with the application of psychology as a science, whether members or not of a national, regional, state or local association of applied psychology, are invited to participate in these meetings. The proposals for the American Association of Applied Psychology are published in full in the June issue of *The Journal of Applied Psychology.*

The need for a professional psychological organization had its inception in 1917 among psychologists in the United States Army during the World War and an association of clinical psychologists was then formed which in 1919 became the Clinical Section of the American Psychological Association. State associations of professional psychology commenced their development in 1921 with the New York State Association of Consulting Psychologists, out of which grew the present regional Association of Consulting Psychologists with a membership in twenty-one states and the District of Columbia. Now there are about fifteen state and regional associations, including associations well advanced in professional organization in New Jersey, Pennsylvania, Ohio, Minnesota, Illinois and Indiana. The proposals provide for an amalgamation of all professional psychological interests along similar lines to those followed by other professional national bodies.

The National Committee for Affiliation of Applied and Professional Psychology, which is composed of Robert G. Bernreuter (Penn. State), Francis N. Maxfield (Ohio State), Donald G. Paterson (Minnesota), Martin L. Reymert (Mooseheart) and Douglas Fryer (N. Y. U.), *chairman,* has had the assistance of a number of special committees in the preparation of its plans for the association. The program of the Minnesota meetings is prepared by a committee of affiliated organizations, of which Robert A. Brotemarkle, University of Pennsylvania, is chairman. Reports of applied research will be given on the mornings of August 30 and 31 and the afternoon programs consist of symposia for the discussion of professional problems such as the standardization of psychological measures, the training and interneship of applied psychologists, methods of conducting surveys of group attitudes and market research, the development of technical psychological manuals, the establishing of quantitative standards for the licensing of professional psychologists and planning for technical exhibits of psychological work.

The organization for an educational section has been prepared by a committee of fifty educational psychologists under the chairmanship of P. M. Symonds, Teachers College, Columbia University; for a clinical section it has been prepared by a committee under the chairmanship of F. N. Maxfield, the Ohio State University; for a consulting section by a committee under the chairmanship of Richard Paynter, Long Island University, and for an industrial and business section by a committee under the chairmanship of Harold E. Burtt, the Ohio State University. Organization meetings for these sections will be held on August 30. Proposals for the organization of a board of affiliates, for the representation of state professional associations, have been prepared by J. Q. Holsopple, Trenton. The board of affiliates, which will integrate state professional activities on a national basis, will have its organization meeting on August 31. Members of the association may be accepted as members of specialized sections according to standards established by them, and these sections and the board of affiliates will have representation in the governing body of the association.

MARINE BIOLOGICAL LABORATORIES

THE Marine Biological Laboratory at Woods Hole, Mass., has opened its fiftieth summer season with the largest attendance in its history. The number of investigators and research assistants, when the registration for 1937 is complete, promises considerably to surpass the previous high figures of 362 in 1931 and 358 in 1936. The registration in the courses of instruction, which is limited by the available classroom space, as in past years, will be about 140. Of the five courses given in 1937, those in embryology, physiology and protozoology will be held during the first and those in invertebrate zoology and botany during the second half of the summer. As head of the course in invertebrate zoology, Professor T. H. Bissonnette, of Trinity College, this year succeeds Professor E. C. Cole, of Williams College, whose very successful services in this capacity began in 1932. Among the recent additions to the scientific equipment of the laboratory the most important is a new and very powerful x-ray unit, which will be under the general scientific supervision of Dr. G. Failla, of Memorial Hospital, New York City, and will be operated by an experienced technician. Another recently completed and useful aid to investigation is a large dehumidified room in which electrical measurements and experiments of various

sorts can be carried on satisfactorily during the dampest weather encountered at the seashore. Among other special equipment housed in this room will be hydrogen and glass electrodes for hydrogen-ion determinations; these instruments, like the x-ray plant, will be under the supervision of a trained operator whose services will be available at all times to those who need them. As in past years a glass-blower, a photographer, a scientific artist and several mechanics will assist in caring for the more highly technical needs of investigators.

During the present summer the Scripps Institution expects a number of visiting investigators who will work together with the members of the staff or be engaged in special research, mainly on biological problems and on marine sediments. In the summer session of the University of California a lecture course, Introduction to Oceanography, will be offered. At the end of June members of the staff will take part in a third cruise on the *Bluefin,* the boat of the California Fish and Game Commission, in order to continue, in cooperation with the Fish and Game Commission, the studies of the currents in the general area between Point Conception and San Diego. Two cruises, during each of which about thirty stations were occupied, have already been completed. No field work at sea can be undertaken by the institution alone, since the boat *Scripps* was lost in November last and since the new 104-foot auxiliary schooner that R. P. Scripps has bought for the institution will not be ready for work before the end of the summer. The new boat is being remodeled, a small deck-house laboratory is to be built, laboratories below deck to be equipped, and winches and other gear to be placed on deck. It is hoped that the boat will be transformed into an excellent ship for oceanographic work and that a systematic study of the waters off the coast soon can be commenced.

The Mt. Desert Island Biological Laboratory at Salisbury Cove, Maine, is open as usual this year from June 15 to September 15. Dr. Earl O. Butcher, of Hamilton College, is acting director in the absence of Dr. William H. Cole. No courses of instruction are offered, but facilities for research in biology are available for independent investigators. Sixteen workers have arranged to work at the laboratory this summer, studying such subjects as pharmacological effects on the blood pressure of elasmobranchs, maturation in various molluscan eggs, color changes in invertebrates, kidney function in fishes, digestion in medusae and gametogenesis in gasteropoda. It is also planned to continue the project of taking motion pictures of typical marine invertebrates for instructional use.

AWARDS OF LATIN AMERICAN FELLOWSHIPS BY THE GUGGENHEIM FOUNDATION

TEN scholars from Latin America will work in the United States during the year 1937–38 on fellowships granted by the John Simon Guggenheim Memorial Foundation. The foundation was established in 1925 by former United States Senator Simon Guggenheim and Mrs. Guggenheim, in memory of a son, and its endowment fund is wholly their gift. The Latin American fellowships are at present available to citizens of Argentina, Chile, Cuba and Mexico, as well as to Puerto Ricans. The grants are made, on terms similar to those governing the Guggenheim fellowships awarded annually to citizens of the United States, to scholars and artists of proved ability in their field of work. The selection of the fellows whose names are now announced was made by a committee of scholars which met in New York, with the advice and assistance of scholars of the countries in which applications originated. About two hundred applications for Latin American fellowships were received this year.

The awards are as follows:

CONRADO FEDERICO ASENJO, instructor in chemistry, School of Tropical Medicine, San Juan, Puerto Rico: Chemical studies of medicinal and poisonous plants of the West Indies.

DR. ALFREDO BAÑOS, JR., professor of theoretical physics in the faculty of physical and mathematical sciences of the National University of Mexico: Continuation of studies in the field of theoretical physics, with emphasis on the theory of cosmic radiation, at the Massachusetts Institute of Technology. (Renewal.)

DR. CARLOS GARCÍA ROBIOU, assistant professor in anthropology, University of Habana: Archeological and ethnological studies of aboriginal remains of Cuba which are to be found in certain museums of the United States.

CARLOS GRAEF, professor of mathematics in the National School of Physical and Mathematical Sciences, Mexico: Studies of the theory of probability and the mathematical theory of statistics, at the Massachusetts Institute of Technology.

ANDRÉS HENESTROSA, librarian of the Department of Foreign Relations, Mexico: Continuation of studies of the significance of Zapotecan culture, chiefly in the Department of Middle American Research, Tulane University, New Orleans. Mr. Henestrosa is himself a Zapotecan Indian, born in the state of Oaxaca, Mexico. He spoke only the Zapotecan language until he was fourteen years old. (Renewal.)

DR. JOAQUÍN LUCO, chief of practical work and associate professor in the department of physiology, Catholic University of Chile: Experimental studies in physiology, in particular the action of certain drugs on smooth muscle. Dr. Luco will work at the Harvard Medical School with Dr. Arturo Rosenblueth, a former Guggenheim fellow from Mexico who is now an assistant professor of physiology at Harvard.

Dr. Alberto Marsal, acting professor of biochemistry, Medical School of the National University of Cordoba, Argentina: Studies in the biochemistry of the thyroid gland, chiefly at the Harvard University Medical School.

Dr. Enrique Savino, bacteriologist of the Institute of Bacteriology of the National Department of Hygiene, Buenos Aires, Argentina: Continuation of studies in the field of public health, with emphasis on epidemiology, at Harvard University. (Renewal.)

Professor Santos Soriano, acting professor of microbiology, University of Buenos Aires, Argentina: Studies of the artificial production of bacterial variations, in certain research institutions in the United States. Professor Soriano has published the results of many studies in the field of microbiology, some in collaboration with his wife, who is a doctor of natural history.

Dr. Silvio Arturo Zavala, research assistant at the National University, Mexico: A comparative study of the systems of forced labor in the Spanish and English colonies of North America, in consultation with scholars in the United States.

The trustees of the foundation are Senator and Mrs. Guggenheim, Francis H. Brownell, Carroll A. Wilson, Charles D. Hilles, Roger W. Straus and Charles Earl.

The Committee of Selection consisted of President Frank Aydelotte, Swarthmore College, *chairman;* Dr. Thomas Barbour, professor of zoology and director of the Museum of Comparative Zoology, Harvard University; Dr. Elmer Drew Merrill, administrator of the Botanical Collections of Harvard University; Dr. Antonio G. Solalinde, professor of Spanish at the University of Wisconsin; Dr. Hans Zinsser, professor of bacteriology and immunology at the Harvard Medical School.

SCIENTIFIC NOTES AND NEWS

At the commencement of Yale University on June 23 the doctorate of science was conferred on Dr. John Howard Northrop, Princeton, N. J., member of the Rockefeller Institute for Medical Research, and on Dr. Ernest Orlando Lawrence, professor of physics at the University of California.

Rutgers University conferred on June 13 the degree of doctor of laws on Dr. James Rowland Angell, retiring president of Yale University, and the degree of doctor of science on Dr. Edward R. Weidlein, director and vice-president of the Mellon Institute, Pittsburgh.

The degree of doctor of science was conferred at the commencement of Tufts College on June 14 on Dr. Leonard Carmichael, professor of psychology and dean of the Faculty of Arts and Sciences of the University of Rochester.

Dartmouth College at commencement conferred the degree of doctor of laws on Rear Admiral Richard E. Byrd and the degree of doctor of science on Dr. Edward R. Baldwin, director of the Edward L. Trudeau Foundation at Saranac Lake, and on Dr. Waltman Walters, surgeon of the Mayo Clinic.

The degree of doctor of science was conferred by Coe College on June 7 on Dr. Horace W. Stunkard, professor of biology, New York University. Dr. Stunkard received the degree of bachelor of science from Coe College twenty-five years ago.

At its commencement exercises on June 14, the University of Colorado conferred the degree of doctor of science on Dr. Sara E. Branham, senior bacteriologist of the U. S. Public Health Service at Washington, in recognition of her contributions to bacteriology in relation to public health.

Dr. Irvin Abell, since 1904 professor of surgery at the University of Louisville, Kentucky, was made president-elect at the eighty-eighth annual meeting of the American Medical Association, held in Atlantic City from June 7 to 11.

Dr. Henry A. Christian, Hersey professor of the theory and practice of physic at the Harvard Medical School, has been elected a corresponding member of the Medico-Chirurgical Society of Edinburgh.

At the annual convention of the American Laryngological Association at Atlantic City, the De Roaldes Medal for research on nose and throat ailments was awarded to Dr. Lee Wallace Dean, head of the nose and throat department of the Washington University School of Medicine, St. Louis.

W. H. Swanger, chief of the section of mechanical metallurgy and assistant chief of the division of metallurgy of the National Bureau of Standards, and G. F. Wohlgemuth, associate metallurgist, have been awarded the Charles B. Dudley Medal for 1937 for their paper entitled "Failure of Heat-Treated Steel Wire in Cables of the Mt. Hope, R. I., Suspension Bridge," which describes the extensive work undertaken by the National Bureau of Standards to determine the causes of the failure. This medal, which commemorates the name of the first president of the American Society for Testing Materials, is awarded to "the author or authors of a paper presented at the preceding annual meeting which is of outstanding merit and which constitutes an original contribution on research in engineering materials." The medal will be presented to Messrs. Swanger and Wohlgemuth on June 30 during the fortieth annual meeting of the society in New York City.

THE Emil Chr. Hansen Gold Medal and a prize of 3,000 Danish crowns has been awarded to Dr. Aurelio Quintanilha, professor of botany at the University of Coimbra, for his investigations on sex in the Hymenomycetes.

THE Adlerschild of the German Empire has been awarded to Dr. Vladimir Köppen, professor of meteorology at the University at Graz.

THE Albert I of Monaco Prize of 100,000 francs has been given by the French Academy of Medicine to Dr. Paul Bouin and Dr. Ancel for their work on the sex hormones and the interstitial glands in man.

DR. PHILIP A. SHAFFER, professor of biological chemistry and head of the department in the Washington University School of Medicine, St. Louis, has been appointed dean. He succeeds the late Dr. W. McKim Marriott, who shortly before his death had resigned to become dean of the Medical School of the University of California.

DR. EDWARD J. VAN LIERE, acting dean of the School of Medicine of West Virginia University, has been made dean. He has been professor of physiology at the university since 1922.

DR. HENRY B. HASS, director of research of the department of chemistry of Purdue University for the past year and a member of the staff since 1928, has been made head of the department. He will take over the work that has been conducted by an administrative committee of which he was a member.

DR. ABEL WOLMAN, chief engineer of the Maryland State Department of Health, has been appointed professor of sanitary engineering at the Johns Hopkins University. John C. Geyer, assistant professor of hydraulic and sanitary engineering at the University of North Carolina, has been appointed associate.

DR. J. H. RUSHTON, assistant professor of chemical engineering at the University of Michigan, has been appointed professor of chemical engineering at the University of Virginia.

DR. GEORGE W. KIDDER, of the department of biology at the College of the City of New York, has been appointed assistant professor of biology at Brown University.

DR. THOMAS PARK, associate in the department of biology of the School of Hygiene and Public Health of the Johns Hopkins University, has been appointed instructor in zoology at the University of Chicago.

DR. WALTER C. LOWDERMILK has been appointed chief of the Soil Conservation Service. He will assume full responsibility for the development and prosecution of a broadened research program adequate to meet the pressing need for additional basic information in the relatively new field of soil erosion control. He will continue for the present to serve as associate chief of the service. Dr. Lowdermilk was formerly project leader in charge of studies in erosion and stream flow at the California Forest Service Experiment Station. In 1933 he was named vice-director of the Soil Erosion Service of the Department of the Interior. When this agency was transferred to the Department of Agriculture as the Soil Conservation Service, he became associate chief.

DR. OSKAR BAUDISCH has been appointed director of research at the New York State Research Institute for Hydrotherapy at Saratoga Spa. The new research institute is a memorial to the late Professor Simon Baruch, of Columbia University.

DR. RICHARD PEARSON STRONG, professor of tropical medicine at the Harvard Medical School, who has spent five months in Peru in connection with his study of parasitic pernicious anemia, returned to New York on June 15. He was accompanied by Mrs. Strong and by members of the expedition: Dr. Emory Pinkerton, pathologist; Dr. David Weinman, research fellow; Dr. Marshall Hertig, entomologist, and M. L. Bennett, technician.

DR. MAX MASON, member of the executive council of the California Institute of Technology, formerly president of the University of Chicago and of the Rockefeller Foundation, was the commencement speaker at the institute on June 11.

DR. WALTER TIMME, professor of neurology at the College of Physicians and Surgeons of Columbia University, addressed the graduates at the ninety-first commencement exercises of the College of the City of New York.

DR. WARFIELD T. LONGCOPE, professor of medicine at the Johns Hopkins University and physician-in-chief of the Johns Hopkins Hospital, gave the address to graduates of the Albany Medical College on June 14.

THE seventh John Mallet Purser Lecture was recently delivered by Professor E. D. Adrian at Trinity College, Dublin. His subject was "The Physiology of Sleep."

THE new exhibit hall of the Mount Wilson Observatory and an auditorium seating 275 people was dedicated on June 14. Dr. John C. Merriam, president of the Carnegie Institution of Washington, D. C., made the principal address.

THE Case Chapter of the Society of the Sigma Xi held its annual initiation on the evening of June 4. Four faculty members and sixteen students were elected to full membership. Officers elected for the

next year were Professor G. L. Tuve, *president;* Professor G. E. Barnes, *vice-president;* Professor T. M. Focke, *treasurer,* and Professor Richard S. Burington, *secretary.* Following the ceremonies, at which Professor J. R. Martin, retiring president, presided, Professor Philip Morse, of the Massachusetts Institute of Technology, spoke on "Physics in Industry."

THE Executive Committee of the International Council of Scientific Unions will meet at Paris, to meet the Committee of Scientific Experts, on July 9 and 10, by invitation of the Organisation Internationale de Coopération Intellectuelle of the Society of Nations.

A SUMMER evening course on modern aspects of organic chemistry is being given at the University of Chicago on Monday evenings from 7 to 9 P. M., beginning on June 21. The program for this course is as follows: "The Application of the Theory of Absolute Reaction Rates to Some Typical Organic Reactions," Professor Henry Eyring, Princeton University; "Unit Processes in Organic Synthesis," Dr. P. H. Groggins, Bureau of Chemistry and Soils; "The Mechanism of Organic Reactions in Gaseous State," Dr. Louis S. Kassel, Universal Oil Products Company; "Some Problems in the Field of Carbohydrate Chemistry," Professor William Lloyd Evans, the Ohio State University; "Infra Red Absorption Spectra of Organic Compounds," Dr. Oliver R. Wulf, Bureau of Chemistry and Soils; "A Survey of the Sulfur Compounds," Professor E. Emmet Reid, the Johns Hopkins University; "Chemistry and Physiological Function of Vitamin B_1," R. R. Williams, the Bell Telephone Company; "Recent Advances in Rubber Chemistry," "Organic Fluorides," Thomas Midgley, Jr., Ethyl Gasoline Corporation; "The Theoretical Principles of Catalytic Reactions," Dr. V. N. Ipatieff, Universal Oil Products Company, and "Heavy Hydrogen in Organic Chemistry," Dr. Weldon G. Brown, University of Chicago.

THE annual spring meeting of the Indiana Academy of Science was held under the presidency of Dr. Will E. Edington, at Winona Lake, Ind., on May 21 and 22. On the evening of May 21 a brief business session was held; and talks were given on lake borings by Dr. Ira T. Wilson, and on the work of the Indiana University Biological Station on the lakes of Northern Indiana and lake problems by Dr. Will Scott. On May 22 there was an early morning bird tour of the region, and a demonstration of lake-boring apparatus and types of work done at the Biological Station. In the afternoon there was a visit to the near-by state fish hatcheries; and the botanists devoted themselves to an exploration of the spring flora of the vicinity. Over one hundred members were in attendance.

LECTURES and demonstrations of the most modern treatments of all types of eye diseases and disorders given by sixteen leading ophthalmologists during a six-day post-graduate course in ophthalmology were conducted by the School of Medicine of the George Washington University during the week from May 31 to June 5. Those who took the course spent an afternoon at Walter Reed Hospital, where they heard lectures and attended demonstrations by Major Frederic Thorne, Captain R. F. Brandish, Lieutenant-Colonel James E. Ash and Captain Elbert DeCoursey, all of the United States Army Medical Corps. Another afternoon session was held at the National Bureau of Standards, where the group were conducted on a tour of the laboratories of the optics division. Members of the staff devoted the afternoon to the discussion of problems in the field of physics and optics and of allied subjects of practical value to clinical ophthalmologists. Those who spoke were Dr. K. S. Gibson, Dr. D. B. Judd, Dr. W. F. Meggers, Dr. I. C. Gardner, Dr. M. G. Lloyd, F. J. Bates and A. N. Finn.

A COURSE in dental science will be given under the auspices of the department of anthropology at Columbia University during the next academic year. It will be directed by Dr. M. Russell Stein, instructor in dental anatomy at the Columbia School of Medicine, and will include the anatomy of human dentition, evolution and comparative anatomy, evolutionary theories, dental fossils of apes and primitive man, primitive dental customs, folk lore of the teeth, comparative and human dental pathology and early and modern dental therapy. Students will be instructed by visual methods. The lectures will be illustrated by dental specimens carved in soap, as well as with lantern slides, blackboard drawings and charts. Examinations will consist of identifying animal and human teeth from small collections as they might be gathered in archeological research.

APPLICATIONS, accompanied by recommendations from directors of museums, for the position of interne, are invited by the Buffalo Museum of Science, where six vacancies in biology, anthropology and the physical sciences are to be filled. These positions have been provided for by a grant of $50,000 from the Rockefeller Foundation.

THE Council of the British Association has resolved, according to *Nature,* that the association should become a constituent member of the Parliamentary Science Committee, and appointed as its representative Professor Allan Ferguson, one of the general secretaries of the association. The arrangement made is subject to revision after three years. *Nature* points out that the announcement will afford particular pleasure to the members of the British Science Guild,

which has now been incorporated with the British Association. The Guild and the Association of Scientific Workers were the parent bodies of the Parliamentary Science Committee, which came into being in October, 1933, almost immediately after the presidential address of Sir Frederick Gowland Hopkins at the Leicester meeting of the British Association.

FIGURES have recently been issued by the Soviet Union Year Book Press Service, according to *Nature*, relating to the increase in the number of Soviet professional workers in the Ukraine. In 1914, the territory now constituting Soviet Ukraine had 44,083 teachers; at the beginning of the school year 1936–37 the number had risen to 150,000. The number of medical men in 1913 was 5,192; in 1936 it was 19,266. The number of secondary medical staff in 1913 was 8,357 and in 1936 40,243. In 1934 there were 83,390 engineers and technical experts employed in the Ukraine; in 1936 the number had increased to 116,600. The number of agronomists employed by the Commissariat of Agriculture in the Ukraine three years ago was 8,200; in January, 1936, it was 12,346.

DISCUSSION

COBALT—AN ESSENTIAL ELEMENT IN ANIMAL NUTRITION—AUSTRALIAN INVESTIGATIONS

IN 1933 Filmer,[1] working with Underwood in Western Australia on a disease of cattle and sheep (characterized by progressive emaciation and anemia followed by death), to which he gave the name "enzootic marasmus," pointed out the similarity between this disease and "bush-sickness" in New Zealand, "nakuruitis" in Kenya, "pine" in Scotland, and "salt-sick" in Florida. The iron deficiency theory which had been advanced to explain the etiology of these diseases was criticized and the hypothesis advanced that enzootic marasmus was due to a deficiency in the herbage of some trace element which was present as a contaminant of the iron compounds which cured and prevented the disease. This hypothesis was based in the main on the following experimental findings.

(1) Extremely high doses of iron compounds were required for curative results, with very little correlation between the size of these doses and the amount of iron which they supplied.

(2) Fresh and heat dried whole liver was curative in doses which supplied insignificant amounts of iron.

(3) The iron content of "unsound" (*i.e.*, disease-producing) pastures was very little lower than that of normal pastures.

(4) The livers and spleens of affected animals contained excessive stores of iron—the reverse of the condition expected in iron-starved animals.[1, 2]

These workers then produced an iron-free extract of one of the curative iron compounds (limonite $Fe_2O_3 \cdot H_2O$) and found it to be fully as potent in the cure of enzootic marasmus as whole limonite.[3] This effectively settled the iron deficiency theory and gave strong support to the trace element hypothesis. Twelve months later it was shown by a fractionation method[4] that the potency of this extract, and therefore of whole limonite, was due to the cobalt which it contained. Normal growth and health of sheep in the affected area was obtained with doses of cobalt chloride supplying as little as 0.1 mg cobalt and of cattle with 0.3 to 1.0 mg cobalt daily, and it was suggested that cobalt must be considered an essential element in animal nutrition.

At this time Marston and Lines were working on a rather similar problem in South Australia known as "coast disease" of sheep. They could neither cure nor prevent the disease with the particular iron compounds used in the doses supplied and tried the effect of adding a number of trace elements, including cobalt, to the sheep's diet. The cobalt was suggested by its known effect in producing polycythemia in rats. Success with doses of cobaltous nitrate supplying 1 mg cobalt daily per sheep was reported by Marston and Lines[5] and to these workers must be given the credit of having first successfully used cobalt in the treatment of a disease of animals.

During this time the iron deficiency theory was not proving an entirely satisfactory explanation of the etiology of "bush-sickness" in New Zealand. Rigg and Askew found only very small differences in the iron contents of "sound" and "unsound" herbage in the south island and suggested soil contamination with iron as a factor in the incidence of the disease. Later they found that the curative effect of certain soil and limonite drenches did not depend solely on their iron contents. In the north island Grimmett and Shorland[6] found the iron contents of various iron ores inadequate to account for their differences in curative value. The experiments of Filmer and Underwood with "iron-free" extracts were then repeated with "bush-sick" animals. Successful results with such extracts were obtained both in the north and south islands.[7] Significant amounts of cobalt were noted in

[1] *Aust. Vet. Jour.*, ix: 163.

[2] Underwood, *Aust. Vet. Jour.*, x: 87, 1934.

[3] Filmer and Underwood, *Aust. Vet. Jour.*, x: 84, 1934.

[4] Underwood and Filmer, *Aust. Vet. Jour.*, xi: 84, 1935.

[5] *Jour. Council Sci. and Indust. Res. Aust.*, 8: 111, 1935.

[6] *Trans. Roy. Soc. N. Z.*, 64: 191, 1934.

these extracts and experiments initiated to test its potency just as the report of the findings of Underwood and Filmer with this element were received. Successful treatment of bush sickness with small amounts of cobalt were reported by Askew and Dixon as mentioned above and later by Wall.[8] Since that time a considerable volume of work on the relation of cobalt to the incidence and control of bush sickness has been carried out by the New Zealand workers, not the least important of which is the development of a chemical method capable of determining as little as 0.2 gamma cobalt.[9]

E. J. UNDERWOOD

DEPARTMENT OF AGRICULTURAL CHEMISTRY,
COLLEGE OF AGRICULTURE,
UNIVERSITY OF WISCONSIN

A POSSIBLE SOURCE OF LABORATORY FIRES[1]

THE conditions necessary for the observation of the phenomenon described herein are common to most laboratories, and the possibilities they have for causing laboratory fires may be already generally known. However, since there is apparently no record in the literature it seems advisable to describe an experience that might well have resulted more disastrously than it did.

On opening the laboratory after a week-end the room was found to contain smoke and there was an odor of burnt wood. The source of the smoke and odor was found to be a smouldering area on a laboratory table top near a two-liter florence flask filled with benzene. The flask and its contents were quite warm, but fortunately the flask was not stoppered, being, instead, covered with an inverted beaker. The burned place in the table was curved in shape and a defect of about one half inch had been made. It was found that what had happened was that the round flask filled with perfectly clear fluid had acted as an efficient sun glass and brought the sun rays to a focus on the table. The laboratory had been closed for a period of one and a half days, during which time the sun shone brightly. The laboratory table was on the south side of the room near a large window, and sunlight was able to enter for a considerable portion of the day. The table top was black, and it was easy to demonstrate that in a few moments the flask placed in bright sunshine caused the wood to smoke. A hole was burned in a piece of black paper almost immediately. Inflammable liquids (ether, benzene, carbon disulfide) poured on the table evaporated before they could be ignited.

It is quite certain that had the flask been tightly stoppered the increased temperature would have burst the flask and brought the highly inflammable benzene in contact with the glowing embers to cause a fire. Also had the table top been of softer wood, as for example pine, the focused sun rays may have induced a flame.

It seems a worthwhile precaution to avoid storing clear fluids in globular glass vessels where they are exposed to direct sun rays, unless they are placed on a white table covering. It may be that the nature of the fluid in the flask, its color and the amount in proportion to the capacity of the flask influence the possibility of the sun glass effect.

JULIAN H. LEWIS

[7] *N. Z. Jour. Agr.*, 50: 267, 1935; Askew and Dixon, *N. Z. Jour. Sc. and Tech.*, 18: 73, 1936.

[8] *N. Z. Jour. Sc. and Tech.*, 18: 642, 1937.

[9] Kidson, Askew and Dixon, *N. Z. Jour. Sc. and Tech.*, 18: [illegible], 1936.

[1] From the Otho S. A. Sprague Memorial Institute and the Department of Pathology, University of Chicago.

"HYPOTHECATE" VERSUS "ASSUME"

IN a recent proof of the Proceedings of the American Physiological Society appears the phrase: "Each hypothecated element in the nerve." This misuse of the word hypothecate in scientific literature is not infrequent. The dictionary defines "hypothecate" as "give or pledge as security; pawn or mortgage." I am myself to blame for the introduction of finance into physiology through the term "oxygen debt." I should be sorry, however, to have it go too far, or to see my friends, on both sides of the Atlantic, reduced to pawning the elements either of their nerves, or of their hypotheses. Let them "assume" these elements, not "hypothecate" them.

A. V. HILL

UNIVERSITY COLLEGE, LONDON

WILLIAM MORTON WHEELER AND THE CLASSICS

No friend of William Morton Wheeler can read unmoved the beautiful appreciation of him in SCIENCE. May I add a word on a point barely noticed?

The reader of Wheeler's great monograph on the ant will not fail to see how intimate he was with Vergil's "Georgics." But very few of his friends and pupils are aware that a commanding knowledge of the Greek and Latin classics made part of the superb intellectual equipment of this self-taught man. He read them as we read French or German. One day last summer he said to me: "I have just read Aeschylus, Sophocles and Thucydides, and Tacitus." Of course it was Greek that he cared for most. When a boy he picked up a speaking knowledge of the modern lingo from Greek fruit sellers in the streets of Milwaukee. From that he worked backward, and it was not long before he was carrying a Greek classic in his pocket.

HENRY OSBORN TAYLOR

SCIENTIFIC BOOKS

MODERN PHYSICS

Die Bedeutung der Modernen Physik für die Theorie der Erkenntnis. Drei mit dem Richard Avenarius-Preis ausgezeichnete Arbeiten von Dr. Grete Hermann, Dr. E. May, Dr. Th. Vogel. viii + 210 pages. S. Hirzel, Leipzig. 1937.

The Philosophy of Relativity. By A. P. USHENKO. 208 pages. George Allen and Unwin, Ltd., London, 1937. $3.00.

THESE two works illustrate the lively interest which philosophers are exhibiting in the philosophical implications of the quantum theory and theory of relativity. The German work consists of three excellent essays which received prizes in a recent competition conducted by the Academy of Sciences of Saxony. The tenor of the first two essays is conservative; both authors argue that fundamental presuppositions, such as the principle of causality and the concept of substance, which have been inherited from historical theories of knowledge, are basic for the new physical theories. Dr. Hermann distinguishes between causality and predictability, and thereby preserves the principle of causality for quantum mechanics. Her thesis is valuable in that it calls attention to the fact that measurement, in quantum theory as well as classical physics, involves a coupling between the value of a physical quantity of an object and the value of some indicating quantity of a measuring instrument. Dr. Hermann also presents an illuminating analysis of the Lorentz transformation. The conclusion of her monograph is that space and time and causality are preserved in the newer theories; it is their relativistic application which is new in the theories of relativity and quantum mechanics.

Dr. Hermann's essay is essentially an analysis of fundamental concepts and principles of physics. In the longer work of Dr. May the more detailed epistemological presuppositions are studied. He argues correctly that the fundamental concepts of the theory of knowledge are presupposed by the new as well as by classical physics. Of especial importance is his demonstration that the quantum mechanical disturbance of the object in observation is reducible to the empirical fact that a measuring instrument interacts with the object, and has nothing whatsoever to do with the philosophical problem of the perception of an external world. Dr. May adopts Dr. Hermann's distinction between causality and predictability and thus obtains a basis for the assertion that the realm of physical processes is strictly determined, even though exact prediction is not possible. The reviewer disagrees with this dualism between physical reality and its theoretical representation, and also with the thesis that space is known to intuition as necessarily Euclidean and time as absolute. But a discussion of these philosophical matters, to which the physical theories are indifferent, is hardly a suitable topic for a limited review.

The third essay by Dr. Vogel reveals an influence of logical positivism which restricts philosophy to a clarification of the meaning of language and of the calculus which constitutes mathematical physics. Dr. Vogel, however, retains his sense of reality and insists that natural science is more than a language. He emphasizes the function of principles of correlation between symbols and experience. This paper contains an excellent analysis of causality.

In contrast to the philosophical conservatism of Hermann and May and the positivism of Vogel, Professor Ushenko argues that new metaphysical doctrines are implied by the theory of relativity. He states that classical physics was based upon the concept of substance, whereas in the theory of relativity the concept of event is basic. He develops a metaphysics of events with much brilliant analysis. Events, which are agents of the physical world, are described by dispositional characteristics, *i.e.*, by characteristics which are not manifested unless an observer is present; but an event must have an essence which is distinct from its dispositional properties, in order to exist in its own right. This essence is a fusion of space and time. Space-time is a structure of events which transcends experience, but is the condition of correlations of acts of experience.

The reviewer believes that both classical and relativistic physics may be interpreted in terms of a metaphysics of substance or events. Indeed, we have seen that Dr. May asserts the necessity of the concept of substance in the new physics. Professor Ushenko asserts that size, shape and mass are the three properties which condition the sameness of substance, and since these properties are relative they can not determine unambiguously the identity of a physical substance. But the electric charge of a body and space-time interval are invariants which may provide for the self-identity of substance. Furthermore, it might be argued that constancy, and not invariance, should be adopted as the criterion of substance. While electricity may be interpreted in relativistic theory as substance, a substantial entity of classical physics may be interpreted as a series of events. Indeed, Mach interpreted the things of classical physics as complexes of elements of sensation. The reviewer believes in opposition to the theory of the present book that the essence of an event may be expressed as the law of correlation of its perspectives.

The book is intended for philosophers. In order to assist their understanding of relativity the author presents simplified mathematical expositions of the special and general theories. The analysis of physical concepts, however, is not as penetrating as that of Dr. Hermann's essay.

V. F. LENZEN

UNIVERSITY OF CALIFORNIA, BERKELEY

SOCIETIES AND MEETINGS

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE thirty-sixth annual meeting of the North Carolina Academy of Science was held at Catawba College, Salisbury, N. C., on May 7 and 8. This was the first time that this institution has been host to the academy. About two hundred and fifty members and visitors attended the meeting. Forty-four papers and four exhibits made up the program. The proceedings will be published in the *Journal of the Elisha Mitchell Scientific Society*.

The General Section met on the first day with P. M. Ginnings, president of the academy, presiding. The reading of papers, mostly of general interest, commenced at 9:30 A.M. and continued until 4.30 P.M., when the annual business meeting was held. The principal matters taken up were the reports of the various committees and the election of officers.

Resolutions were read honoring the late Dr. David H. Howard, Jr., department of chemistry, Davidson College. The academy elected to life membership Professor C. W. Edwards, department of physics, Duke University, and Dr. A. S. Wheeler, recently retired acting chairman, department of chemistry, the University of North Carolina. The executive committee reported the election of 38 new members since the last meeting and the reinstatement of 7 former members.

In the high-school science essay contest, sponsored by the academy, first prize was awarded to Miss Lucy Nelms, Nashville High School, Nashville, N. C., for her essay entitled "Thumbs Down on Erosion." This contest will be continued in 1938 in the fields of physics and chemistry.

Dr. John N. Couch, department of botany, the University of North Carolina, was awarded the Phipps and Bird medal for the most noteworthy paper, entitled "A Fungus that Catches Nematodes."

The American Association for the Advancement of Science research grant for 1936 was awarded to Mr. D. S. Correll, department of botany, Duke University, for the continuation of his studies of the orchids of the southeastern states. The grant for 1937 was awarded to Dr. L. G. Willis, North Carolina State Experiment Station, for the continuation of his studies on the oxidation-reduction equilibrium in soils.

A complimentary barbecue supper was served on the college lawn to the members of the academy and visitors. This was followed by a one-act comedy by the local dramatic club.

The evening meeting was presided over by the vice-president, C. F. Korstian. Howard R. Omwake, president of Catawba College, welcomed the academy. This was followed by an address, entitled "The Interdependence of the Sciences," by the retiring president, P. M. Ginnings, Greensboro College.

At the conclusion of the evening meeting, President and Mrs. Omwake entertained the officers and members of the academy at an informal reception in their home.

The forenoon of the second day was set aside for the presentation of the more technical papers, and the academy therefore met in sections as follows: General Section (botany, zoology, forestry, geology), Mathematics Section and Physics Section. The Chemistry Section did not meet at this time.

The following officers were elected for 1937:

GENERAL SECTION

President, W. E. Speas, Wake Forest College.
Vice-President, M. L. Braun, Catawba College.
Secretary-Treasurer, H. L. Blomquist, Duke University.
Executive Committee, the above officers and W. L. Porter, Davidson College; H. R. Totten, the University of North Carolina; R. F. Poole, North Carolina State College.
Representative to the American Association for the Advancement of Science, Bert Cunningham, Duke University.

CHEMISTRY SECTION

Chairman, W. C. Vosburgh, Duke University.
Vice-Chairman, Neville Isbell, Wake Forest College.
Secretary-Treasurer, E. C. Markham, the University of North Carolina.
Councilors, D. G. Hill, Duke University; R. W. Bost, the University of North Carolina.
Executive Committee, the officers and C. S. Black, Wake Forest College; W. A. Reid, North Carolina State College; Edward Mack, the University of North Carolina; W. E. Jordan, North Carolina State College.

MATHEMATICS SECTION

Chairman, J. J. Gergen, Duke University.
Secretary, Archibald Henderson, the University of North Carolina.

PHYSICS SECTION

Chairman, J. B. Derieux, North Carolina State College.
Secretary, F. W. Lancaster, North Carolina State College.

The thirty-seventh meeting of the North Carolina Academy of Science will be held in 1938 at North Carolina State College, Raleigh, N. C.

H. L. BLOMQUIST,
Secretary

SPECIAL ARTICLES

THE EFFECTS OF ALCOHOL AS INFLUENCED BY BLOOD SUGAR[1]

IT has long been recognized that when alcohol is taken by mouth the presence of food in the stomach influences its effects. The action of the food is purely physical; it dilutes the alcohol and slows its absorption so that the concentration of alcohol in the blood does not rise as high as it would if the stomach were empty and the absorption rapid. The observations that we have now to report introduce another similar, but heretofore unrecognized, factor. We find that the increase of sugar in the blood, which follows a meal, greatly lessens the pharmacological effect of alcohol that has been absorbed. Our investigation has been made chiefly on rats, but we have evidence that men react similarly.

Our results were obtained by determining the concentration of alcohol in the blood required to produce definite effects at various concentrations of blood sugar. This was death from respiratory failure in the case of experimental animals. To obtain valid results in any study of the relation between the concentration of alcohol in the blood and the resulting effects, it is necessary to take into consideration the factors that control the distribution of alcohol in the body. Failure to do so has led to many misinterpretations in work of this kind. The factors that control the distribution of alcohol are essentially the same as those which I established for ethyl ether.[2]

The intoxicating and lethal effects of alcohol arise from its action on the brain. The concentration of alcohol in the brain depends upon that in the blood reaching the brain and the rate of circulation through the brain. The effects of alcohol correspond precisely to the concentration of alcohol in the jugular blood leaving the brain and are independent of the concentrations, higher or lower, that may be found in blood drawn from other parts of the body.

Complete equilibrium throughout the body, following intraperitoneal injection of a single large dose of alcohol in a rat, may take more than an hour; short of this equilibrium wide differences may exist in the venous blood drawn from various parts of the body, due largely to differences in rate of local circulation. Thus following the injection into a rat of 20 mg of alcohol per gram, a fatal dose, blood drawn from the jugular vein at the moment of death had 9.4 mg per cc, that from the femoral vein 6.3 mg per cc, the right heart 16.0 mg and the arterial 15.8 mg. We have found, however, that, regardless of excess of the dose given or of the time required to cause death by respiratory failure or of the concentration in the blood from the heart or peripheral veins, that in the jugular vein of fasting rats (blood sugar 0.1 per cent.) is at the moment of death always 9.0 to 9.8 mg per cc. The concentration of alcohol in the jugular blood thus affords a basis for comparison in the study of the influence of variation in blood sugar upon the lethal concentration of alcohol. It is one that is not influenced when the equilibrium of alcohol in the body is incomplete.

For confirmation of our determinations we have made measurements of dosage as well as concentrations. To do so it was necessary to develop a technique of administration by which a nearly complete equilibrium could be maintained throughout the body. Small but uniform doses of alcohol were administered intraperitoneally every 5 minutes over a period of several hours. Under the condition thus induced and maintained the concentration in the blood in all parts of the body is virtually uniform. Thus three measurable factors, time, dose and blood concentration, can be accurately determined. For the lethal effect of alcohol all three factors were found to be constant but constant only when the concentration of sugar in the blood is also constant.

The toxicity of alcohol is influenced inversely by the concentration of sugar in the blood. Thus when the blood sugar is reduced by prolonged fasting to 0.07 per cent. the lethal concentration in the blood is 8.0 mg per cc of blood; when the blood sugar is 0.1 per cent., as following a short fast, the lethal concentration is 20 per cent. higher, that is, 9.5 mg per cc. When the blood sugar is raised to 0.2 per cent. by forcing sugar the lethal concentration is 50 per cent. higher than that during starvation, that is, 12.0 mg per cc of blood. The amounts of alcohol that were administered under our technique to obtain these values are respectively 6.5, 7.75 and 11.0 mg per gram of rat. For intermediate values of blood sugar the lethal concentration of alcohol and the dose fall correspondingly between these limits. Very high concentrations of sugar, far beyond normal possibilities, obtained by injection of sugar do not increase the protective action and in some cases diminish it.

Similar experiments carried out with ethyl alcohol and with ether, which unlike ethyl alcohol are not appreciably burned in the body, showed that the concentration of sugar in the blood does not influence the lethal concentration of these substances. The presumption is therefore that the modifying effects of sugar upon the action of alcohol is in some way connected with the combustion of alcohol in the tissues.

The alcohol used in these experiments was commercial spirits, common grain alcohol. We have made additional tests with highly purified alcohol and with

[1] Read before the National Academy of Sciences, Washington, D. C., April 26, 1937.

[2] H. W. Haggard, *Jour. Biol. Chem.*, 59: 737–802, 1924.

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